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The Sequence of Areal Occupance in a Section of St. Louis, Missouri

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The Cheltenham District, which is located in the western part of St. Louis, includes the principal factories which have given to that city a nationwide reputation for the manufacture of various types of clay products. As may be logically assumed, the present landscape is the resultant of many forces, some of which are still operative, and others, though inactive at present, have left their traces. The purpose of this study is to resolve the geographic landscape into its component stages, and reconstruct the geographic complex for each stage. Five such stages have been found, as follows: (1) Pioneer, (2) Farmer, (3) Village, (4) Mining, and (5) Manufacturing (Fig. 1).

The first stage had its setting and beginnings shortly after the founding of St. Louis (1764). The region west of the little fur-trading post presented a view of gently undulating upland hills and broad shallow valleys, accordant to two small streams, Petite Rivière (Mill Creek) and River des Peres (Fig. 2). The valleys were densely wooded with various species of oak, maple, walnut, elm, and hickory. The narrow divides and hills were covered for the most part with oak trees interspersed with openings. The broad interstream uplands were mostly prairie, dotted with oak and hazel. Bordering the old Spanish-French village on the west were the commons—"fields" and "pastures." Both were fenced, the former to keep stock out, and the latter to keep

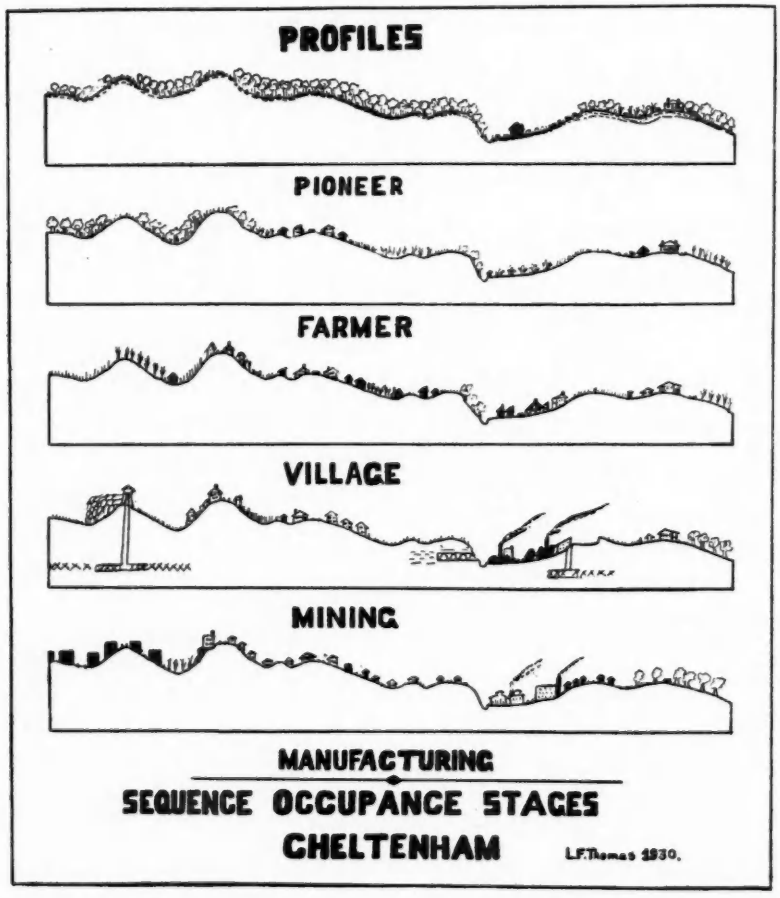

FIG. 1—North to south profiles across the Cheltenham District representing typical landscape features during each of the geographic stages of its occupance by white men.

stock in. As may be seen in Figure 2, the pastures extended to the western edge of Grand Prairie. Beyond stretched wilderness.

Because the forest along the River des Peres was especially magnificent, and because there were many springs in and along the course of that stream, the senior Charles Gratiot saw an oppartunity to make a splendid beginning toward his ambitions to amass

a fortune in real estate. Consequently, in 1785, twenty-one years after the founding of St. Louis, he petitioned the Spanish authorities as follows:[1]

> "To Don Francisco de Cruzat, Lieutenant Colonel of the regiment established in Louisiana and Lieutenant Governor of the western part of Illinois, etc., etc.; Sir—Charles Gratiot a merchant of this village has the honor to inform you that he desires to establish a habitation on the River des Peres to cultivate wheat, oats, Indian corn, tobacco, etc., etc. This he means to do, Sir, if it pleases you to grant a tract of land of eighty-four arpents in width running from east to west, the line crossing the river eighty-four arpents in length passing from north to south following the afore mentioned river to the end of the concession at the bull pen of Desnoyer, to enjoy by himself or to dispose of to his heirs with his other property now and forever, without interference from others in the matter of enjoying or disposing of the property. When this is done all will be right.
>
> At St. Louis, the twelfth of February seventeen hundred and eighty-five. Charles Gratiot."

His petition was granted two days later, and the tract of land which was about three miles square (6,720 arpents or 5,716.7 acres) has been known ever since as Gratiot's League.

[1]Manuscript, Missouri Historical Society, St. Louis, Mo.

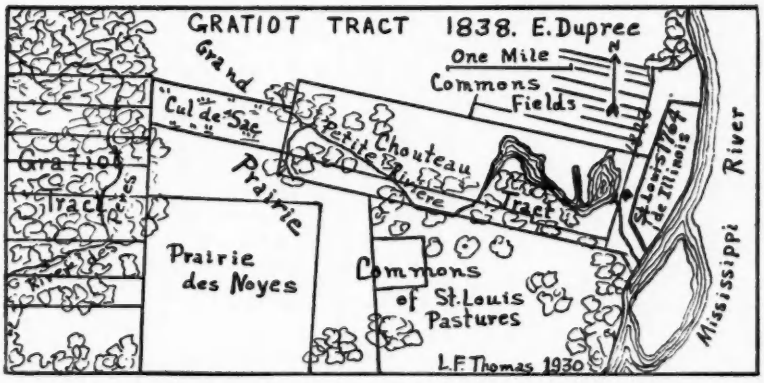

FIG. 2—The Cheltenham District lies within the Gratiot Tract shown on the western part of the map. This map is a composite based on fragments of maps and descriptions in the collection of the Missouri Historical Society.

It may be surmised from the fact that he maintained a mansion in the village that he did not move out to his granted tract, in spite of a clause which stipulated that, "he will make it fertile within a year, otherwise the land will be taken away and made the property of the Royal Domain." However, clearing the land must have been construed as a step toward making the land fertile, since he retained ownership undisturbed until his death. A subsequent petition disclosed that his chief development on the property was the building of a sawmill. He stated that, "he was a most ancient inhabitant and the father of a numerous family"; and that "out of the indulgence he has had for those who cut wood on his property, it is now in part destitute of timber," hence he felt the necessity of asking for 500 additional arpents "so that the sawmill which he had established would not become a loss through his failure to provide himself with timber." This petition was readily granted a few days later, January 15, 1800.

Apparently up to the time of his death in 1819 little or no settlement took place on the tract. The only indication of settlement shown on the plat filed by the administrators of his will, was the "Berry Farm" indicated by diagonal shading in Figure 3.[2] It seems

[2]Copy of will, Missouri Historical Society.

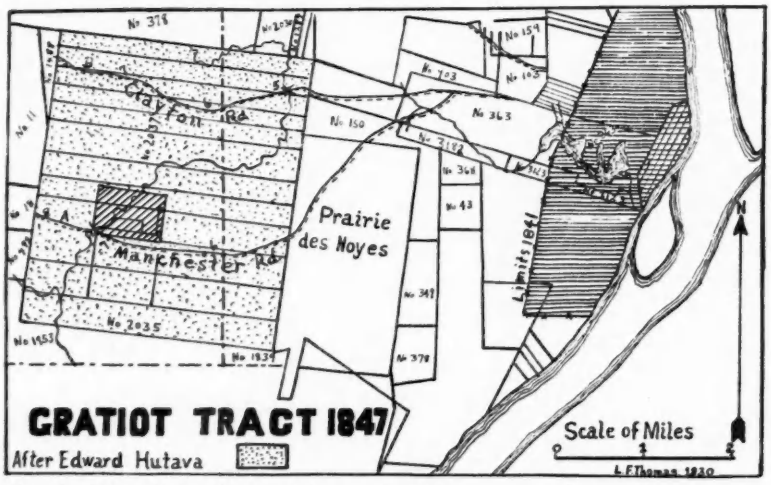

FIG. 3—Map of the Gratiot Tract and vicinity, representing conditions at the beginning of the Farmer Stage of Occupance. It shows the undivided parallel strips of land awarded to the Gratiot heirs by the administrators. The diagonally shaded area represents the Berry Farm.

safe to assume that the chief utilization of the Gratiot League during the period 1785 to 1830 involved little cultivation of the soil and was concerned principally with the features of the forest —wood, timber, game.

The landscape of the second stage of occupance reflects mainly agricultural occupance (Fig. 1). By 1830 all the land surrounding the Gratiot League had been purchased or secured by petitions and claims. As intimated in the preceding paragraph a few settlers had purchased land from the Gratiot heirs. One of these was Robert Campbell who bought a farm along the River des Peres. One of the chief attractions of the farm was a large sulphur spring which bubbled up from the bottom of the stream. On this account Campbell named it Cheltenham in honor of the famous watering-place by that name in Gloucestershire, England.

Although some of the land of the Gratiot League is too steep for cultivation by modern machine methods, practically all of it could be tilled by the farmers of this pre-machine stage of occupance. As far as may be judged, the whole tract was gradually brought under cultivation. The soils brought to light by clearing and tilling were of different types and qualities according to their origin and topographic location (Fig. 4). The geological background for these soil types is a mantle of glacial loess and clay, overlying, in the eastern part of the league, Pennsylvanian "coal measures," and in the western part, Mississippian limestone.

The Memphis and Clinton soil types are by far the most widespread.[3] The Memphis is deep loessial, while the Clinton is shallow loessial. Both may be used for general farming, although the Memphis is more productive. The Muscatine type is a sour, dark upland soil, occurring on nearly level land and underlain by compact, impervious subsoil. These two conditions render both surface and soil drainage very slow. The Waverly type is a valley-bottom soil where the River des Peres has cut into the coal measures. It varies from putty-like soils in the clays to mellow texture in the sandstones. The Genesee type is an alluvial mixture with much humus, in characteristic floodplain structure. It is an excellent soil and is especially good for corn in general farming, and for many vegetables in truck farming.

The climate of this district is favorable for the growth of corn, winter wheat, oats, clover and hay. The growing season averages

[3]Krusekoff, H. H., Soil Survey of St. Louis County, Mo., 1923, U. S. Bureau of Soils.

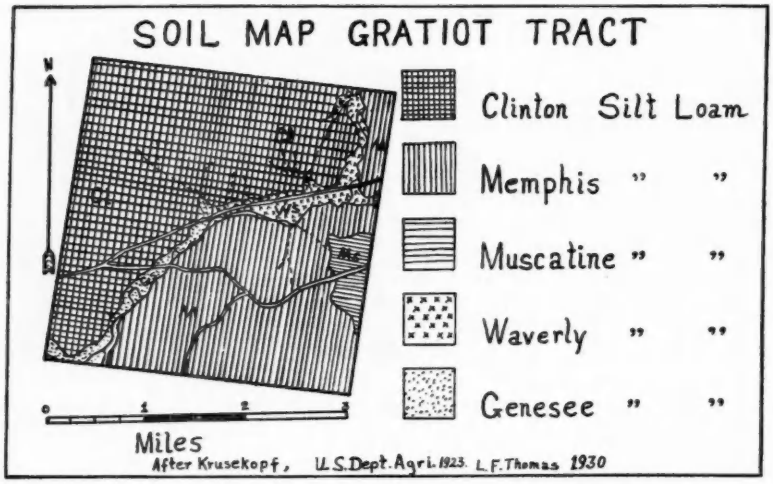

FIG. 4—Soil map of the Gratiot League. Cheltenham is located just west of the symbol "W. S."

190 days, usually from about April 6 to October 24.[4] More than 50% of the 37.2 inches of annual precipitation falls during the late spring and early summer months. Mild winters are common while bitter temperatures are rare. Late summer droughts are common and sometimes curtail crop yields. In general, however, agricultural practices were successful, and were maintained in a few localities until very recently. About 1839 the district began to feel the influence of the growing city of St. Louis, and as a result tendencies toward intensified farming practices and suburban occupance began to show along the arteries of travel.

The landscape of the third stage of occupance (Fig. 1), in which both suburban villages and farms were prominent features, had its beginnings in the survey and improvement of New Manchester Road (Fig. 5; *cf.* Fig. 3). Heretofore, the main roads had been Old Manchester Road and Clayton Road, which were laid out on the upland to the south and to the north of the River des Peres in the Cheltenham District (Fig. 3). The valley route was subject to sudden floods and involved adjustments to sinkholes and glades. The opening up of this direct route seems to indicate

[4]Thomas, Lewis F., Climate of St. Louis, Mo., Washington University Studies XII (1924), 4.

the emergence from a farming to a village occupance, demanding better transportation lines.

During the period of this stage many subdivisions were platted, some with large lots designed for small farming activities, others with small lots for suburbanites. Apparently the urge existed then, as now, to live beyond the city limits, and to enjoy rural social, economic, and tax conditions. The valley of the River des Peres with its clear waters, numerous springs, knolls and hills, made an inviting landscape. Gratiot, Gratiot Place, Mound St. Louis, The Glades, and Sulphur Springs were real estate ventures in the immediate vicinity of Cheltenham.

The general trend during this period, 1839-1852, was toward more and smaller lots. This is indicated by the number of parcels of land in the Gratiot League: 1785—1, 1819—9, 1830—99, 1840—264, 1850—305. Apparently small lots suited the purchaser and subdivider. As time passed, however, it became more and more noticeable that the damp airs of the valley floor subjected the inhabitants to malarial conditions. As a consequence, those who could afford healthful locations avoided these valley sites, and the poorer residents became segregated in the valley villages. The mining and manufacturing activities of the succeeding stages tended to intensify and increase their numbers.

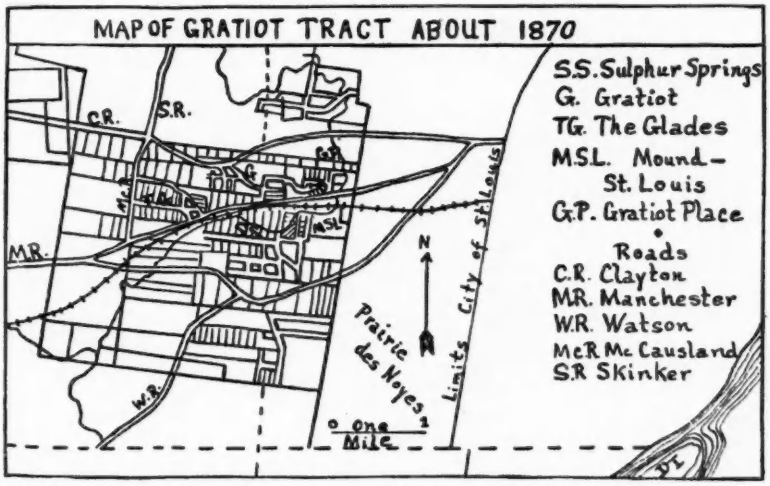

FIG. 5—Map of the Gratiot League showing conditions typical of the third state of occupance, which featured many residential subdivisions and small farms.

The landscape of the fourth stage (Fig. 1) resulting from mining activities as the cause of the dominant features, possessed a curious commingling of farming, suburban, mining, and manufacturing elements. Although fire clay was discovered at Cheltenham in 1844, and although present-day companies have rival claims as to priority of establishment in the 1840s, it is generally conceded that real development on an important scale did not begin until the early fifties.[5] The estimated value of clay products made in this district over a long period of years has averaged about $5,000,000 annually. Ten important companies have contributed to this value, some mining clay, some manufacturing clay products, and some engaged in both activities. Fenneman in his study published in 1911,[6] evaluated the importance of the district thus:

> "The output of clay products from St. Louis was, in the year 1908 valued at $5,000,000. This is about one thirtieth of the entire output of the United States. The products here counted comprise those of fire clays, shales, and brick clays. In as much as a very large proportion of the total consisted of fire clay products, and as those were derived in large part from a single area within the city limits, it may be seen that this is one of the most important centers of the clay industry."

As stated above, three sorts of clays are available in this district. From these raw materials clay products are made as follows: fire brick from fire clay, sewer pipe and terra cotta from shales, and building brick from loessial clays. One of the early geologists, Shumard, in his geological survey of St. Louis County, noted a synclinal structure in the Pennsylvanian coal measures just west of St. Louis.[7] Fenneman at a later date attributed the preservation of these formations, consisting of clays, shales, coal seams, sandstones, and thin-bedded limestones, to the "slight down folding . . . below the level to which streams could cut" in this area during the "erosion which in or before Tertiary time reduced the country to a peneplain."[8] The Cheltenham farm area included the exposure of the contact between the Pennsylvanian shales and

[5]Thomas, Lewis F., Localization of Business Activities in Metropolitan St. Louis, Washington University Studies, N. S. No. 1 (1927), 90.

[6]Fenneman, N. M., Geology and Mineral Resources of the St. Louis Quadrangle, U. S. Geological Survey: Bulletin 438 (1911).

[7]Shumard, B. F., 1st Ann. Rept., Geological Survey of Missouri (1855).

[8]Fenneman, *op. cit.*, 49.

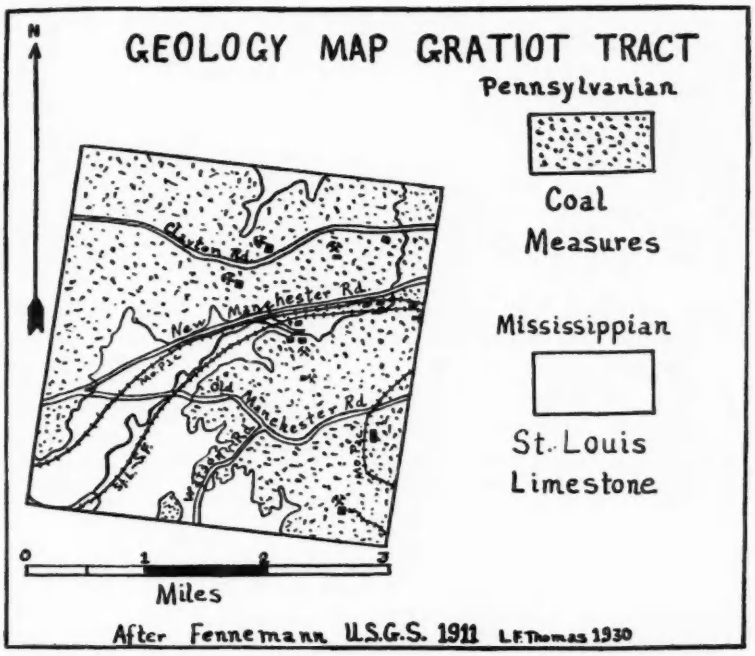

FIG. 6—Geology of the Gratiot Tract. The cluster of black squares just south of the word "Manchester" in "New Manchester Road" marks the location of Cheltenham.

the Mississippian St. Louis limestone in the channel of the River des Peres at the sulphur springs (Fig. 6). Where the now famous fire-clay bed was exposed in the bank of the River des Peres, these Paleozoic formations are overlain by a veneer of glacial loess which varies in thickness from 0 to 40 feet (Fig. 7). As a consequence, the clays according to type are worked from shafts 60 to 100 feet deep, in drifts in the valley walls, or in open pits on the hills and slopes. Underground, the single entry, room-and-pillar method is used. Eventually the pillars are drawn and the roof settles gradually.

After the fire clays are brought to the surface they are allowed to cure or weather from two to four years, usually three, in broad, low piles, around the mine head. Before the shale and loessial clays are used for sewer pipe, terra cotta, or bricks, they are allowed to dry in long low wooden sheds. The clay-products fac-

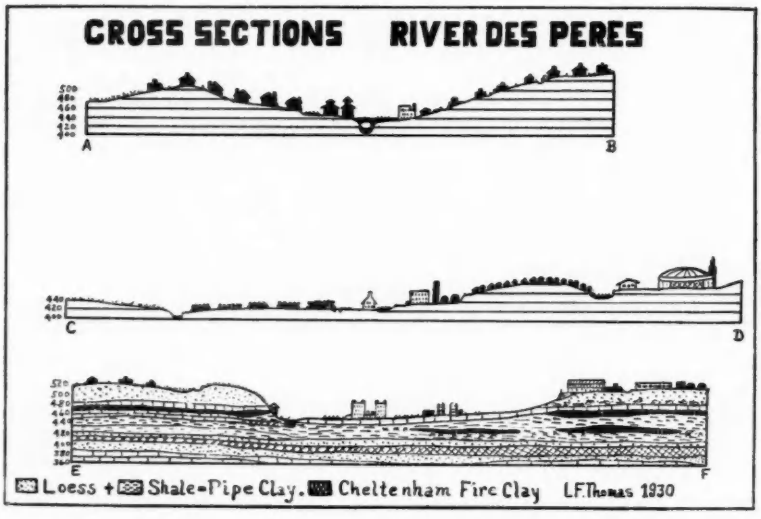

FIG. 7—Cross-sections of the River des Peres Valley in the Cheltenham District. The locations of these sections may be seen in Figure 11. The figures at the left of the sections represent feet above sea level.

tories are large buildings, four and five stories high, with many kinds of clay-shaping machinery. Arranged in rows alongside the buildings are kilns, the type determined by the method of burning or the kind of products manufactured. Surrounding the plants are extensive acreages occupied by piles of brick and sewer pipe arranged like cord-wood. Various products are stored in large, low sheds. The ensemble of these features has produced a "clay-products landscape"

The period of this development, climax, and decline covered some seventy years. Early in the period, 1852, the Pacific Railroad (Missouri Pacific) was built through the district, thereby affording access to wider markets, and better access to Illinois coal. The St. Louis-San Francisco Railroad increased the accessibility in 1883. Highways were improved by paving and lighting. Street railway service began with horse cars and evolved into electric cars and motor buses. In 1876 the city of St. Louis extended its limits some distance beyond Cheltenham, thus annexing it (Fig. 8).

In spite of these betterments in transportation and political status, residential changes were slow. The subsurface workings

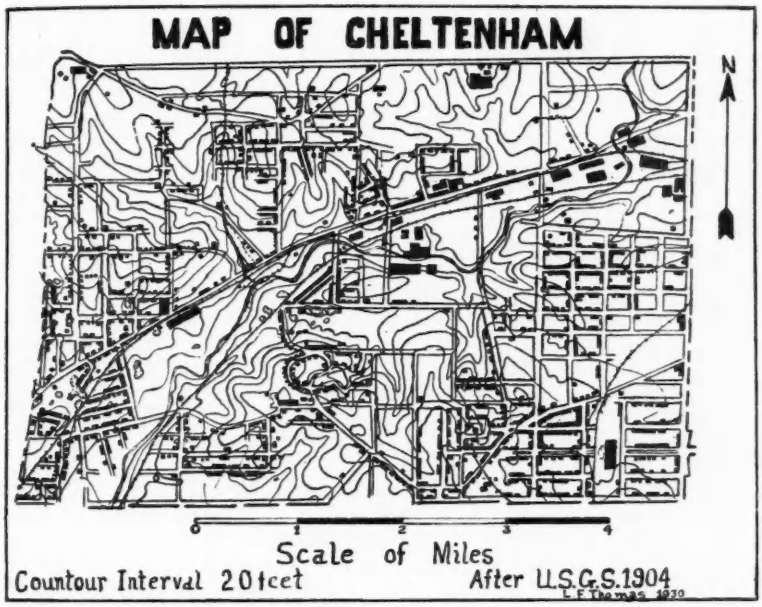

FIG. 8—Map of Cheltenham District in 1904. Note that the principal residential sites are on the valley walls and adjacent uplands. Also, note the large proportion of vacant land.

in the clay beds created a hazard which many home owners were unwilling to risk, since the sinking or settling of the surface might take place at any time. Furthermore, the copious smoke and dust were not attractive, to say the least. Moreover, the industry engaged types of workers who maintained standards of living not acceptable to the better circumstanced class of citizens. As a consequence, many of the subdivisions laid out during the previous stages were withdrawn from sale, and streets created on paper never took form on the ground. The surface of the greater part of the clay properties today lies idle, is covered with weeds, or is occupied by scattered squatters.

Although the industry has drawn largely upon Italian and negro labor, there was in the early days an unusual labor group. These were members of "Colonie Icarienne," a French communistic society which had branches at Nauvoo, Illinois, and Cheltenham, Missouri, in the 1850s. It is believed that by their skill and industry they greatly stimulated the clay industry, if they did

not actually set it going. Malarial fevers, financial troubles, and disgruntled members eventually proved too great a handicap for this branch and it disbanded in 1858. The negro laborers come and go daily, and none reside in the vicinity. The Italians are densely crowded in small cottages on the valley walls and uplands. On the south side, known as the "Hill," the Italians have a complete set of community activities, including stores, shops, shows, clubs, churches, and schools (Fig. 9, *cf.* Fig. 8).

FIG. 9—Map of Cheltenham in 1930. The large black patches indicate the factories and commercial plants. The dotted areas show extent of acreage used for materials storage. Checks show idle surface lands of clay properties. The densely built-up area in the east center is the Italian "Hill."

The fifth stage of occupance began about 1925 (Fig. 1). At that time the Cheltenham District began to show signs of a change in activities. Due to the exhaustion of some of the clay properties, and due to the increasing costs of working others, some companies have retired from the field, dismantled their plants and sold their land. Others have changed from fire brick to sewer pipe, since there is still much shale clay available on their properties. A few have opened pits or mines elsewhere and bring the clay to their Cheltenham factories by rail. These changes have set in motion the present trends in the district.

The transition from an exclusively clay-products district to a diversified business district might have been long and slow. However, the rapid completion of the River des Peres project precipitated the movement into a fairly rapid metamorphosis. In the Spanish grant to Gratiot, the River des Peres was reserved for public use as a navigable waterway. For many years the normal flow of this stream has been confined to a large sewer through the Cheltenham District. After severe rain storms, as if in vengeance, the river emerged and spread widely over its floodplain. The frequency of such emergencies appeared to be on the increase, due to the increased rate of run-off as the headwaters of the river became urbanized. With the completion of the Cheltenham section of gigantic new sewers in 1928, the flood hazard has been eliminated

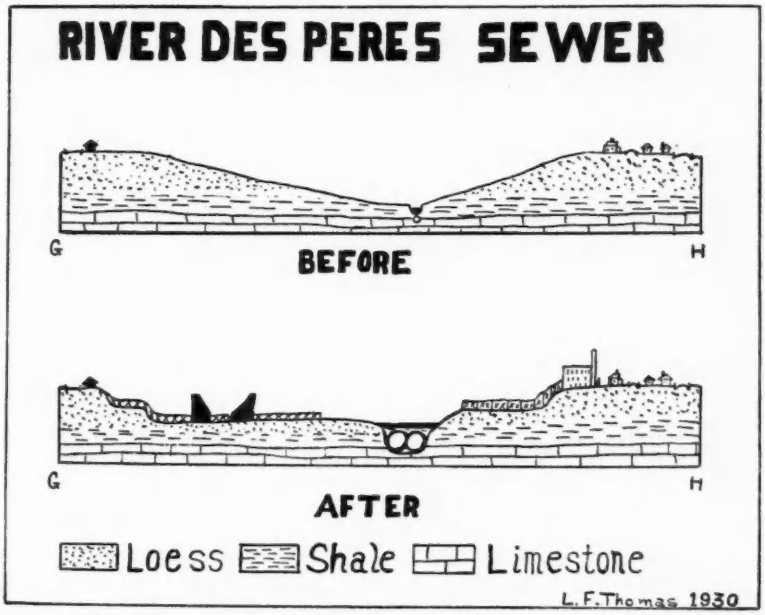

FIG. 10—Cross-sections of the River des Peres Valley before and after the completion of the new sewers (Fig. 11, G-H). The upper section shows the normal slopes of the valley walls, the small cess-sewer beneath the stream, and the small channel which was inadequate to carry the increasingly copious storm waters. The lower section shows the two new large tubes, and the artificial valley form due to excavations in the shale and loess, thereby increasing the size of sites for factories, stadium, etc. (This cross-section cuts through the properties of one of the leading fire-brick companies.)

from the district (Fig. 10). Through a part of the district the river is entirely subsurface in two tubes, each twenty feet in diameter; in the other part there is a surface storm-water channel made of concrete. By means of these improvements, involving the straightening of the course, considerable areas of land have been made serviceable for industrial or commercial use (Fig. 11).[9]

It seems to be the experience of companies handling large quantities of heavy or bulky materials and products, that trackside locations are more economical than off-track sites. As a consequence, the more salable industrial sites are those which have switch-track facilities or those to which such service may be extended. In this district industrial realtors have assumed that sites which involve switch gradients in excess of 2% are practically useless for factories under present conditions. Switch tracks should be as nearly level as possible at the plants in order to obviate rolling during loading or unloading operations.

The factory sites naturally available for development are located along the course of the River des Peres in a strip of land of varying widths. However, in the Cheltenham District, further expansion of sites is possible because of the composition of the valley walls (Figs. 7 and 10). It is feasible with modern excavating machinery to create extensive terraces in the valley wall, or to widen the flat floor of the valley (Fig. 10—"After"). The terraces are reached by low gradient inclines. The valley walls set very definite limits (Fig. 11) to the areas economically worth creating at or somewhat above present land values. During the past eight years, eighteen companies have selected sites and located plants in this district. Some are regular factories, such as the National Bearing Metals Corporation, More-Jones Plant. Some companies operate small machine shops, toolworks, or foundries. A number of concerns are branch warehouses which handle bulky products such as building materials, paving materials, oils, and machinery. Large tracts have been sold or leased for semi-public development such as an athletic stadium, The National Dairy Show, and an amusement park. Since it is rather easy to calculate what areas may be devoted to industrial use and what areas cannot be so used, the non-industrial portions are being rapidly platted and built up for residential use. Present lot values eliminate

[9]The total cost of the complete River des Peres Project is $22,000,000 and was a part of a city-wide bond-issue for improvements.

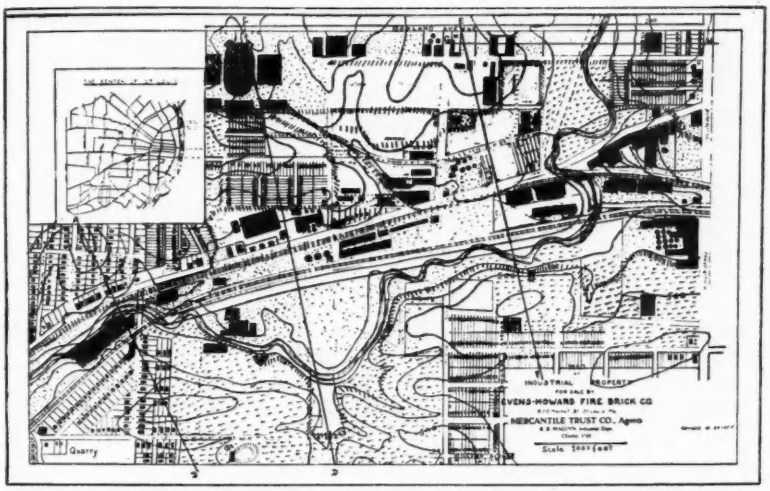

FIG. 11—Detailed map of the Cheltenham District in 1930, showing the location of the profiles A-B, C-D, E-F in Figure 7, and profile G-H in Figure 10. The areas that can be levelled to make factory sites, as in Figure 10 "After," are outlined with hachures. The inset map shows Cheltenham as a black rectangle in a grid of the major streets of St. Louis.

cheap-lot buyers from the district. As a result, rather attractive cottages and bungalows are dotting the landscape.

The topographic location of a piece of property in this district is the critical factor in its investment value. If it is on the naturally smooth floodplain surface of the valley, it has a current value from $8,000 to $15,000 per acre, depending upon specific street and railroad facilities. If it is located on artificially constructed terraces, more or less difficult of rail access, it is valued at about $5,000 per acre, depending upon the size of the tract purchased If it is beyond the possible industrial limits, *i.e.*, slopes too steep or land too high, it has residential subdivision value of about $1,000 per acre. The introduction of natural gas from Louisiana into the factories has eliminated much of the smoke nuisance.

As a summary, it may be noted that the sequence of occupance involving different factors of the natural environment shows increasing land values which reflect varied economic opportunities in a given area:

1. 1785-1830. Pioneer stage. Forests, springs, clearings, crop patches, five miles from St. Louis—$1.25 per acre.

2. 1830-1839. Farmer stage. Gentle slopes, fine textured soil, fair quality soil, long hot summer growing season, normal spring-summer rains, four and a half miles from St. Louis—$30.00 per acre.

3. 1839-1852. Village stage. Similar to (2) but more intensified as to truck and fruit types, four miles from St. Louis—$100.00 per acre.

4. 1852-1925. Mining stage. Clay raw materials, and clay-products plants with associated low-grade residences, annexed to St. Louis—$1,000.00 per acre.

5. 1925-. Manufacturing stage. Railroad switches, factory sites, near the center of Missouri Metropolitan St. Louis, middle class residences—$1,000.00, $5,000.00, $15,000.00 per acre according to topographic location.

The Commercial Importance of Fog Control

ALEXANDER McADIE

Geography is no longer taught as a two-dimensional subject, that is, the mere boundaries of certain surface areas. Our school geographies fifty years ago began to describe customs and manners and later chief industries, exports, etc., and so brought in the human factor. We may define geography today as "all that pertains to human environment."

Are we wrong in suggesting that seismology for instance comes strictly within the purview of the instructor in geography? Is it not important that the class studying social and economic problems of the dwellers in our central southwestern states, should know quite a lot about the oil fields of Texas and Oklahoma. But these are now located mainly by using seismographs and we delve below the surface, although not very far, in interpreting the complex records of the transmitted earth waves due to explosive shocks.

And the geographer should not stop with these skin-of-the-earth phenomena. My colleague, Professor Reginald A. Daly, in his delightful paper "X-Raying the Earth," shows how geology is being remade today and that the geo-physicist holds the center of the stage. It is not so much the features of the surface of the earth that we seek to study, as the layers below, even down to the core. Long elastic waves "set going when the hammer of the deadly earthquake strikes" caught on seismographs at widely separated observatories, bring to light the long hidden secrets of earth's concentric shells. Or again, the sonic depth finder or fathometer, by the echo of sound waves gives the lay-out of ocean bottoms. Surely the Professor of Geography must not omit the mention of these.

It is then, we agree, entirely appropriate for the geographers to explore downward as well as superficially;[1] but if he can go *down*

[1]"While telling us much about the heart of the earth, the seismogram is still more authoritative and eloquent concerning the uppermost layers of the globe. By studying the instrumental records of the reflections, refractions, accelerations, and retardations of earthqake waves, seismologists have found that the continental rocks reach downward about 30 miles. At that level there is a rather abrupt change to a world-circling shell of a quite different nature. The dominant rock of the continents is granite. According to the facts of geology, as of seismology, the underlying shell or substratum is the heavier, dark-colored basalt, and is apparently the source of this commonest of lavas and the primary seat of all volcanic energies." Daly, R. A.: Harvard Alumni Bulletin, Oct. 18, 1928.

he can also go *up;* and thus we have another dimension for geographers, the exploration of the atmosphere. Even in the limited field of human exploration alone we have four dimensions. It is of this last that we speak, of the very bottom layer of the shell of air around the globe.[2]

Here, close to the surface, lies the fog, fine delicate veil that lightly enfolds us all. So wondrous is this fabric, it would seem that a breath of air at times would blow it all apart, and then again at times, so strong, so insistent, so tumultuous that the stoutest ship, the most highly powered plane, yea even the humblest taxi traveling some well known street, acknowledge its power, and stop, thankful to escape collision and disaster.

The destiny of nations has hung upon a fog. Go back to Homer, and you have the never-to-be-forgotten appeal of Ajax to the Thunderer: "O Zeus! Compeller of the Clouds! Take away this dreary darkness! Grant us our dearest prayer—that the sons of Greece may die fighting in the light!"

Or picture if you can, Napoleon beaten in Egypt and hurrying to Paris to save his head from an unfriendly Directorate, crossing the Mediterranean and escaping Nelson's vigilant watch by a few miles of intercepting fog.

Or again our own Washington, beaten in the battles of Long Island, and crossing the East River, almost within sound of Howe's ships, hidden by the friendly fog.

One further case. In the fields of Flanders, the first week of May, 1917. On May 7th the Communiqué reads, "The enemy's artillery was active in all sections. Our guns replied vigorously." Few words to tell a grim tale. From Loos to Fresnoy a thousand guns were roaring. The awful din and hideousness surpassed all previous "symphonies of hell." Two armies, a million men on each fighting line, were at close grips. Battery answered battery; shrapnel drenched the space between the lines. Slowly the night passed, and with the dawn there rose from earth a faint enveloping mist; and still the duel raged between the great hosts. But surely, silently, the wall of white thickened. The growling of the great guns ceased, and e'er a half hour had passed, the smaller guns quit barking. Upon man's mightiest engines of destruction, Nature laid gently a restraining hand, "Thus far and no farther!" Along a battle front of fifty miles this veil of fog set at naught all

[2]When this paper was presented before the Association a slide was shown, depicting the structure of the atmosphere up to 300 kilometers (180 miles).

orders from headquarters. Within an hour it hushed the clamor of Hell and bade the guns be still.

So much for the historical. Coming down to more prosaic lines, when you arrive at the New Jersey terminals, about to cross the river with the great army of commuters hurrying to their daily tasks in the metropolis, you may some morning dive into the fog. Clever indeed are the ferry pilots and matchless in skill as they grope, literally, their way to the New York piers. The fog may obscure the city but often the upper stories of the tall buildings loom up above it. Particularly is this the case with the ground radiation fogs of August mornings, and also on quiet winter mornings under certain anticyclonic stagnant air. On the other hand, there are fogs which obscure the tops of the tall buildings, while in the streets below there exists comparatively clear air, and at least moderate visibility. Even high mountain peaks have their particular fog cover or cloud cap.[3] In such cases the tourist climbs to the top, hopeful to the last of a good view, and finds instead himself immersed in fog. Seen from below the phenomenon is called a cloud; and there is no essential difference between fog and cloud, except that in the latter there is generally present a feeble anabat, or up-current lifting the fog stuff above the ground. The old saw holds "a fog is a cloud on the ground; and a cloud is a fog in the air."

There are, however, many and various kinds of fog. We know of about ten types, depending upon the particular phase of the cooling of the water vapor, the tilt or incline of the air stratum, the temperature of circumjacent layers and the life history of the streams. Every fog (also every cloud) is simply the outward and visible sign of an inner and unseen physical process connected with the condensation or change of form of water vapor in the free air.

Nucleation or the formation of drops as determined by character of kerns or nuclei, plays an important rôle; also I think electrification, that is, the intensity of the electric field. Every fog and every cloud is evidence of an inversion of temperature, a discontinuity in the temperature, a switch-back, so to speak, in the isotherm.

There are, however, two main types, ground radiation and advective, or better, transvective fog. The former is the one we shall discuss in some detail later, believing that the dissipation of

[3]Through the courtesy of Count Abe, who has a private observatory at the foot of Fuji, a slide showed the conditions at the summit of that mountain.

this type of fog is possible and perhaps commercially well worth while. The other type is more troublesome and as yet here is no promise of relief or control.

Ground radiation fog is the lowest of the temperature inversions. Here the heat loss is from the ground, and in due time the air strata with their respective vapor loads are chilled and drain, if the terrain slopes a little, into the low places.[4]

The most interesting of recent advances in connection with the study of fog is the exposition of the fact that there are inversions above inversions. Sir Napier Shaw has written much about air stratification; and we are beginning to realize that air plus water vapor is not just as we thought it—a homogeneous, evenly balanced and regularly layered mass—but an unstable, shifting complex of entities.

The forms of stratification are almost without end, and therefore the forms of stratified clouds vary beyond count. Dr. Sobhog Mal has recently described (Beiträge zur Physik der freien Atmosphäre, XVII Band, Heft 1, s 40, Nov. 1930) an extension of the work of P. Idrac, Terada, Benards, Peppler, Douglas W. Kopp and others giving, on a physical basis, the formation of these upper inversions, and the patterns of the cloudlets, whether in polygons, rectangles, strips or parallel rows.

Experiments on instabilities due to density distribution in a thin layer of fluid (gold paint with benzine and other volatile liquids, also hot liquid spermaceti in which aluminium powder was dissolved) with and without shear, give forms that much resemble cloud appearances. Furthermore just as in these experiments, whenever a cloud sheet is broken into polygons, rectangles, etc., the layer is vertically unstable, but whenever the sheet is unbroken and continuous it is stable. Such a convective layer gives rise to a polygonal pattern when the shear is zero, to a rectangular pattern when the shear is small; and to strips when the shear is large.

An instrument[5] devised by the speaker enables an observer on the ground to quickly get the speed and direction of any of the lower clouds. It utilizes the principle of average lapse rates of temperature as a means of getting heights. A black mirror with certain sextant-like movements of sights gives the angles, and particularly the cotangents, which represent distance travelled

[4]Slides showed the fog in mass and microphotographs of the dust content in certain of the ground radiation and other types, for be it remembered that fog is simply glorified atmospheric mud.

[5]The instrument has been described in the Blue Hill Annals, 1926.

in a given time by the cloud. A timing piece and azimuth or direction finders are added. So fairly accurate is the device that for five years at Blue Hill Observatory, we have been able to tell the wind speed and direction at the surface with great accuracy, by reversing the process, that is, determining speed and direction aloft and using known reduction factors. Of course the exact value of the gradients is desirable. We have been using thus far average values and find these work very well. Tables have been constructed with lapse rates given in kilograds, the new temperature scale where temperature has a definite ratio to volume, the coefficient of thermal expansion of a gas under constant pressure being .001.

Clouds and fogs are, as was said before, evidence of discontinuities of temperature and vapor content, or inversions so-called. The rise in temperature just above the upper surface of clouds and fogs has long been recognized and therefore it will not be difficult to explain why, under some of the fog conditions which we are now about to discuss, at elevations of 200 meters and above, the weather may be pleasant with sunshine and warm, dry air, in marked contrast with conditions below. Thus in a tall building in San Francisco, one may experience on summer days a temperature of 1100 (80° F) on the roof and 1050 (54° F) on ground floor.

We have not space to go into the physical constitution of fogs. Smoke particles[6] average 1 micron (one-thousandth of a millimeter) and the dirt particles 5 to 50 microns. Such small bodies settle slowly, very slowly, hardly one meter in an hour; and if even gentle anabats (up currents) prevail, there may result a slow rise instead of fall. The cloud droplets themselves vary from 0.1 to 1.0 mm.

Shaw points out (Vol. III, Manual of Meteorology, p. 333) that the principle of the parachute operates in connection with the seelement of small drops, "the speed ceasing to increase when the amount of momentum required to displace the air is equal to that derived from the action of gravity upon the falling body. Hence a limiting velocity of fall is ultimately reached, at which a steady motion is attained under balanced forces." Viscosity of the air also comes into play even more than ordinary resistance. Stokes law for velocity in centimeters per second, is

$$V = 2/9\ r^2\ (\varpi - \rho)\ g/\eta$$

where g is acceleration of gravity, r the radius of particle, ϖ its density, ρ the density of the air, and η the coefficient of viscosity.

[6]Slides showing smoke and solid or dirt particles at various places were thrown on the screen.

Rain drops differ from cloud droplets in size and terminal velocities; and for all we know in electric charges. The surface tension of small drops is large; but with rain drops the electric charge may in some way interfere with or lead to a rupture. Just what part chemical action plays depends of course upon the nature of the nuclei. Ammonia or anhydrous sulphuric acid, or in fact almost all chemically pure acids will facilitate condensation. Supersaturation may not be essential. And thus a criticism can be made of the fog-dissipating experiments heretofore tried by using fine sand, that more effective results might have been obtained if the sand had been washed in some very hygroscopic material.

We make the distinction between haze and fog that haze is essentially dry dust particles while fog is a hygroscopic nucleus (kern) with an envelope of water, to which a dirt particle may or may not attach itself. An average ground radiation fog drop has a radius of 0.1 millimeter and a surface area $4\ \pi r^2$ or .126 square millimeter. The surface tension on such a drop approximates 100 dynes per square centimeter; and the viscosity coefficient .02 C.G.S. units.

Turning now to smoke particles, an average value in ordinary impure air is about 150,000 per cubic centimeter. In an ordinary lecture room there could easily be 30×10^{15} smoke particles. Of the relatively large dirt particles in city air, there may be 1,500,000 in a cubic meter of space. Looking over the dust counts in New York City in 1929, we find an average value of 1,360,000/m³. On some days 3,500,000/m³. The following dates were days of excessive dustiness, more than 3,500,000/m³. Jan. 3, 9, 11, Feb. 24, 27, March 15, 16, 23, July 17, Aug. 10, Sept. 7, 25, Oct. 19, 20, Nov. 1, 6, 27. Days of minimum dust load, less than 700,000/m³, were Jan. 8, 19, 27, 29, Feb. 1, 2, 21, March 3, 6, 7, 10, 14, 17, 24, 27, 28, 29, Apr. 2, 17, 18, 19, 22, 23, 27, 29, May 3, 7, 8, 9, 13, 21, 22, 23, 25, 26, 28, June 2, 3, 4, 6, 10, 20, 26, 30, July 2, 3, 8, 11, 15, 19, 20, 21, 22, 26, Aug. 2, 3, 4, 5, 7, 8, 22, 24, 25, 28, 29, 31, Sept. 11, 12, 15, 18, 19, 20, 21, 22, 23, 30, Oct. 1, 2, 3, 4, 9, 10, 11, 15, 28, 29, 30, 31, Nov. 5, 9, 10, 19, 21, 28, Dec. 4, 9, 12, 16, 23.

It appears that there are more consecutive low dust days than high dust ones, which is probably connected with air movement. Low wind velocities as a rule have a longer duration than high winds. Much windiness diminishes the load of dust by mechanically sweeping it away. And in fact, as we shall instance later, it

sometimes needs a vigorous squall to end a period of protracted muggy weather.

An interesting illustration of fog and high dust content is that of March 14, 15 and 16, 1929, at New York City, which was ended by a squall.

We quote from the New York Times of March 17th, 1929:

> "The fog which ended yesterday was called by seasoned mariners, one of the densest and most protracted that has affected the metropolis in 20 years. Trans-Atlantic liners inbound and outbound were forced to anchor, ferry service was either suspended entirely or slowed to such a pace that it seemed asleep; other harbor craft tied up or groped around in the blinding whiteness. Transportation on land moved with great caution and millions of New Yorkers upon arising found their window shades superfluous." (Evidently in New York, when one arises in the morning, it is expedient to pull down the shades.)

Then follows a harrowing description of conditions at the St. George Terminal and other points, illustrating the peculiar psychology of crowds of worried commuters. Until nearly nine o'clock on the morning of the 16th, the fog was so dense that one could not distinguish objects 20 meters away. In the Lower Bay, pilots were unable to move any craft. There is a long list of accidents, including some to airplanes. These latter, however, had further and worse trouble with the squall.

On March 14, with a high percentage of saturation (100%) vapor pressure 11 kilobars and vapor weight 8.4 grams per cubic meter, light northeast wind and poor visibility, temperature 1030 (8° C), there were approximately 70,000 dust particles per cubic meter. On the previous day, a warm dry day on the rear side of a large anticyclone, the number of dust particles was over 200,000/m^3 due to a light wind from the southwest. A moderate northeast wind blowing into an approaching low, brought the dust count up to eight times as much, or over 5,000,000, which was still further augmented, exceeding 6,000,000 on the 16th with warm muggy weather. Then came the sharp discontinuity, or thermal break, horizontally, with the squall; the northwest dry cold wind blowing the fog away.

Here nature effected the cure and dissipated the fog in her own (but rather strenuous) way. The action here was purely mechani-

cal, a vigorous northwest wind sweeping away the fog in short order. The time was brief, perhaps half an hour, in brushing away the fog over a distance of ten miles. The temperature fell about 40 kk (20 Fahrenheit degrees). This type of fog we could hardly expect to dissipate by artificial agencies; just as it is not to be expected that an extensive fog stream such as comes in through the Golden Gate at San Francisco can be dissipated by either thermal, mechanical or electrical methods. The fog supply is on too vast a scale for any hope of control by artificial agencies. With certain of the ground radiation types of fog, the amount is definitely limited and it seems even practicable and perhaps not so very expensive to clear away definite areas or zones; and of course at crowded terminal points this means added safety and a great saving of time.

This can be done by one or more methods. Fortunately the air motion is sluggish, and the fog stuff is like a sediment, concentrated near the ground or water. A block of fog 100 meters thick, 10,000 meters long and 500 meters wide, weighs at a temperature of 1002 kk (33° F) 25×10^{7} grams. The air itself would weigh 62.5×10^{9} grams or 250 times as much. The total weight being 62,750,000 kilograms (approximately 125,000 tons).

A millimeter of rain over the area given would weigh approximately 5×10^{9} grams. If we had to vaporize this, there would be needed 12.5×10^{12} joules, which in kilowatt hours would be 3475×10^{3}. In the language of the bills which we pay at home for light and power at 5 cents per kilowatt hour, the cost would be $139,000 or if the charge was at the rate of 2 cents, $69,500.

Reversing the process, and turning the fog back into water, would probably cost less if we only knew how to set free the energy, thermal or electric, so that the process of rupturing, agglomerating and precipitating the fog droplets would be continuous. Unfortunately we do not understand the vagaries of a film of water, when in the spheroidal stage. A flash of lightning of moderate intensity has enough energy to evaporate 1 millimeter of water per hour; but it fails to dissipate even a moderate sized cloud. And so it seems likely that discharging electricity at tremendously high voltages and amperages (5×10^{10} ergs) will not suffice.

So it is plain that whatever methods are employed the expense will be considerable. Nature working at the top of the fog bank, sends in a beam of strong sunlight, energy over each square meter equivalent to 10^{10} ergs, which will raise the temperature about 20

kilograds. No one on the sun however is concerned with costs and changes! On the other hand, we have seen it stated that the loss to the port of London in the fogs of December 5-6, 1930, was as high as $5,000,000 per day. Allowing ten working hours in the day, this is $500,000 per hour.

In the port of New York, on the two days of March 14-15, 1929, the total loss can only be roughly estimated as exceeding the figure for London. While this was an unusually long fog spell, we estimate that there are no less than 20 days each year when trans-Atlantic liners are held from either entering or leaving port, the best part of a working day.

The time will come, we believe, when it will be found to be commercially profitable to dissipate fog at ferries, railroad terminals and along certain channels and fairways in harbors. Much has been done already in connection with the development of instruments using radio beacons and radio markers, thus enabling safe flying in fog. And if aviators can find their way thru fog, there is no valid reason why sailors can not do likewise.

Instrument flying (previously called blind flying) is now coming into general use and aviators no longer need to see the course although it is always necessary to have some reference point. Also much has been done and more is being done in connection with the penetration of light through fog. Before long this may render fog dissipation a minor problem. Red and especially infra red (lower frequencies and longer wave lengths, say 1 to 3 microns) penetrate fog better than white or yellow, green or blue.

Photo-electric cells responsive to the given radiation can be used to pick up the waves; and for rather longer waves, bordering on heat, thermo-electric couples can be used as detectors. In addition to wave lengths, light flux must be considered. According to Dr. S. H. Anderson (Preliminary Report on Penetration of Light through Fog, AVIATION, May 10, 1930, p. 930) the infra red (1.05 to 2.7μ) required 2260 feet of fog to reduce the radiation 0.1 per cent, whereas with yellow light the length would be 289 feet, and with green 231. The sensitivity of the eye, however, favors yellow. Furthermore there is the matter of the diffusion and scattering of light by the fog particles, and in this, white light has the advantage. But we have made a beginning on the fog problem, and know something of the structure and dimensions of the materials involved; and with increasing knowledge we may yet be able to rob fog of much of its terrors.

Experiments shown in presenting this paper at the meeting of the Association:

1. Cloudiness caused by cooling due to quick expansion.
2. Intensification caused by increase in nuclei.
3. Electrification of water jet.
4. Electrification of spray.
5. Transvection of fog droplets.
6. Rain at a distance.
7. Dissipation of smoke by electrification.
8. Formation of fog.
   a. warm air over cold water as at San Francisco.
   b. cold air over warm water as on Grand Banks.

A. Ceiling semaphore or three dimensional weather board, warning airmen of likelihood of ice formation.

B. Cloud height and velocity indicator.

C. Thermodynamic thermometer for identifying air streams.

Development of the Platte River Bottomland in South Central Nebraska

G. E. CONDRA

The Platte, in its course in south central Nebraska, is widely known as an overloaded river, and it is generally held that its broad valley-floor is an alluvial plain developed in a former deep valley by the river. Also, the lowering of the river in this area, to a dry bed in late summer, is supposed to be caused by excessive evaporation and diversion for irrigation.

Investigations made by the Nebraska Geological Survey and the Nebraska Water Survey disprove most of the generally accepted views of the environing features of the Platte. It would seem, therefore, that as Geographers you may be interested in the results of this investigation.

This paper is only a review of the main points brought out in the study of the Platte River and the Platte Valley. A more complete statement is found in Bulletins 3 and 4 of the Conservation Department of the Conservation and Survey Division of the University of Nebraska, which bulletins are free upon request. Also, there is further treatment of the subject in the 1930 Report of the Nebraska Irrigation Association, and in forthcoming bulletins of the State Geological Survey of the Conservation and Survey Division of the University of Nebraska.

The first point raised here is in regard to the nature and origin of the river bottom land. That this was not aggraded by the Platte, to the depth generally supposed, is evidenced by the following:

1. The so-called alluvium of the valley floor consists of two thick gravel sheets separated by a fairly persistent sheet of silt and clay, all of which extend through this stretch of the valley and out under the broadening uplands. They have a combined thickness of 100′ to 200′, resting on bedrock.

2. The gravel sheets are of Pleistocene age as shown by mammalian fossils brought up from water wells and by pumping and dredging at sand pits. It is certain, therefore, that the sand and gravel deposits under this area of the Platte Valley, up to near the surface, are of Pleistocene age and not recent alluvium. To Dr. A. L. Lugn belongs much of the credit for this discovery.

The Pleistocene deposits enumerated above have a relation to continental glaciation, which extended across eastern Nebraska, and to marginal deposition therewith. The sequence of events in the origin of the gravel sheets and the silty clay bed between them is thought to be as follows:

1. The first advance of the ice obliterated the drainage ways, filled some of the valleys with sub-glacial gravel, and acted as a dam for the east-flowing streams of central Nebraska. The area west of the ice and morainic material was deeply aggraded with outwash from the glacier, and by in-wash over an extensive area west and northwest of the ice dam. This in-wash and outwash deposit is of the age of the Nebraskan till sheet against which it was laid down. It, as noted above, extends under the Platte.

2. With the retreat of the ice, and during the warm period which followed, gumbotil was formed on the Nebraskan drift and a silty-clay sheet was spread widely over the area west of the Nebraskan Moraine. This latter is the silty layer which separates the upper and lower gravels of the Platte Valley and uplands.

3. With the second advance of the ice, a second till sheet, known as the Kansan, was developed, and a second (upper) gravel deposit was formed west of it, like that of the first ice invasion. This sand and gravel sheet is of Kansan age. It too underlies the Platte and the bordering uplands.

4. During the later glaciations of Iowa and Illinois, attendant deposits were formed in Nebraska. Among these deposits are the Loveland and Peorian loess formations.

The foregoing statement indicates how the thick arenaceous deposits under the Platte were developed in connection with glaciation. The sands and gravels were aggraded by various streams leading to near the margin of the ice and to some extent by marginal outwash, and not in an ancient channel of the Platte.

The North Platte Valley of western Nebraska is pre-Pleistocene in age. The stretch of valley from east of Fremont to the Missouri is post-Kansan in age, and most, if not all of the middle course, is post-Loveland in age. Lack of time will not permit a review of the physiographic development of the Platte Valley.

In passing this point it should not be overlooked that the middle course of the Platte is of comparatively late origin. The stream is on the Kansan gravel with only a thin veneer of recent alluvium, and is incompetent to move the coarse gravel, the surface of which coincides with the grade of the river.

The second point raised, is in regard to the dry bed of the river in late summer. This condition has been studied from various angles and it is now believed that the so-called "drying up" of the river is not due in the main to evaporation and the diversion of water for irrigation. Evidently, it can be attributed in the main to stream-bed loss and the consequent underflow through the porous Pleistocene gravels out under the loess plains to the Republican, Little Blue and Big Blue rivers. The water table slopes southeastward from the Platte to the rivers just noted. That the water moves through the sands and gravels and away from the Platte in this manner has been proved beyond question.

The volume of water stored in the sands and gravels in the bottomland of the middle course of the Platte is thought to be equal to about 24,000,000 acre feet, and the amount in the sands and gravels in the Loess plains is more than 50,000,000 acre feet. This vast storage has been replenished in large measure from the Platte River.

Leakage from the Loess plains water-storage built up from the Platte makes the Little Blue and Big Blue live streams. This is true especially of the West branch of the Big Blue, and it seems safe to state that the twenty-two water powers of the Big Blue would have much less importance without the Platte overflow.

The Platte Valley has three well defined natural stretches, as follows:

1. From the mountains to the North Platte.
2. From North Platte to Columbus.
3. From Columbus to the Missouri.

In the first course, the geologic and topographic conditions cause the water diverted for irrigation, except that lost by evaporation and transpiration, to pass into ground storage and back to the river as underflow, called "return flow." Irrigation development through reservoir storage, ground storage and return flow has stabilized the river.

In the second course of the valley, the physical conditions cause the maximum storage of ground water in the bottomland and under-

drainage therefrom. Much of the stream discharge becomes ground water with underflow at all seasons of the year, but the relation of the river to stream-bed loss and underflow is most noticeable during late summer when there is most evaporation and less rainfall, at which time the river dwindles in part through evaporation, but largely on account of its loss to ground water storage, leaving a dry bed just above the water table. The maximum ground water replenishment in the middle course of the Platte is attained during high stages of the river. This ground water has importance in sub-irrigation, well irrigation, domestic and municipal water supply.

The third or lower course of the Platte is the Loup-Elkhorn-Lower Platte. This composite course has a large, uniform discharge from sandhill storage, is supplied from an area of heavier rainfall, and the geologic and topographic conditions, as in the North Platte, direct most of both the surface and underflow to the valley without much leakage loss.

The following features of the Platte have importance in geography:

1. The North Platte is a stabilized river, made so by reservoir storage of flood water and by ground storage and the return flow therefrom.

2. The North Platte and the lower course of the Platte Valley proper are natural water conservancy areas due to the geological conditions.

3. The middle course of the Platte in Nebraska, *i.e.*, between Gothenburg and Columbus, is one in which the river has much stream-bed loss due to ground water storage and underflow away from the valley. This is the main factor in the "drying down" of the river in summer.

4. The Platte, in its middle course, has not filled a former deep valley by the aggradation of sediment brought down from the mountains.

5. The present grade of the Platte in its middle course is due primarily to thick deposits of Pleistocene sand and gravel and the incompetence of the river to move this deposit.

6. The grade of the river and of the Kansan gravel sheet coincide throughout most of the middle course of the Platte, and the variation in valley-depth between Gothenburg and Columbus is due primarily to variation in thick-

ness in the valley-sides of materials of later age than the Kansan gravel.

7. The attendant glacial deposits noted in this review are more complicated in origin than the outwash sands and gravels of New England. They are largely formed of in-wash.

8. Our study emphasizes the relation the Pleistocene gravels have to ground water movement, stream behavior, ground water storage, well water supply, sub-irrigation and pump irrigation.

9. The study has also shown the need for further investigation regarding the methods to be followed in the stabilization of the ground water level at the optimum depth. Such investigation is now under way in coöperation with the U. S. Geological Survey.

Titles and Abstracts of Papers
Worcester, 1930

A. E. PARKINS.

The Antebellum South. (Presidential Address. Published in full in the March, 1931, issue.)

KEITH B. ALLAN (Introduced by Charles F. Brooks).

Tornado Frequencies in the United States and Their Relation to Storm Tracks.

There are three distinct bands of high tornado frequency in the United States according to a map of tornado distribution, 1916-1928. These are northeast Texas to South Carolina, northeast Texas to north central Tennessee, and northeast Texas to north central Iowa. Within these are small areas of greater intensity —the middle Red River Valley, central Arkansas, and northeastern Kansas. Each of these small areas is elongated in a northeast-southwest direction.

In reported average annual tornado frequencies the following states lead: Kansas 13.0; Texas 12.6; Iowa 12.1; Arkansas 8.9; and Oklahoma 6.6.

Seventeen states throughout the zone of maximum frequency are used for a detailed study. The time of maximum frequency varies from the second week in March in Mississippi to the first week of July in North Dakota, but the northward march is not uniform.

The frequency of general conditions favoring tornadoes is shown by the number of days on which tornadoes occur. Three states are chosen for detailed study of cyclone tracks on days when tornadoes occurred. In Louisiana the relation of tornadoes to storm tracks is close, with a few exceptions, the centers of cyclones producing tornadoes in Louisiana follow the southern track, but pass north of Louisiana. In general the low pressure center on the mornings of tornado days is found north and west of Louisiana.

In Kansas the low centers on mornings of tornado days are mostly west of the state, unlike Louisiana, only a few are to the north, while a number are a short distance to the south. Some are in Kansas itself. The majority of these lows are of Colorado origin. The lows move eastward and northward in both states. Tornadoes are not always associated with definite storm areas, the tracks of which are charted by the Weather Bureau. Nine tornadoes occurred in ephemeral local low pressure areas. The months of June, July, and August are most favorable for this con-

dition owing to locally controlled unstable atmospheric conditions over the plains at this season.

In South Dakota tornadoes are not associated with any general storm track as are those of Louisiana and Kansas. There are as many tornadoes in South Dakota associated with North Pacific as Colorado lows. The low centers are usually southeast or northwest of South Dakota on the mornings of tornado days. There is no concentration of the storm areas as with Kansas.

A number of tornadoes occur in South Dakota with local low pressure areas, the ratio being one to six which is twice that of Kansas. Toward the northern interior of the continent local low pressure areas under sun control, in summer, play a proportionately larger part in the formation of tornadoes than to the south, where intense cyclonic action in the spring is such a fertile source of these whirlwinds.

WALLACE R. ATWOOD (Introduced by W. W. Atwood).

The Physiographic Relationships Between the Mid-Tertiary and Permian Peneplains in the Region of the Causses and Cevennes of Southern France.

At the southern margin of the Central Massif of France are two closely associated but distinctly different types of topography (1) the "Causses" and (2) the "Cevennes." The "Causses" consist of several large plateaus composed of horizontally bedded Jurassic limestones, while the "Cevennes" are rugged mountains made up of pre-Cambrian schists and gneisses. At the surface of the ancient rocks is the Permian (post-Hercynienne) peneplain. It is found to truncate the pre-Cambrian and Paleozoic schists, gneisses, and granites, and in turn is buried beneath the Triassic and Jurassic sediments. Uplift and faulting in the region bordering the limestone plateaus has caused erosion of the Secondary sediments and the consequent resurrection of the ancient peneplain surface. It appears very commonly at the eastern edge of the Causses where it issues from beneath Jurassic limestones.

At the surface of the Causses is a much younger peneplain which has been identified as being mid-Tertiary in age. To the east of the Causses, where faulting and uplift have raised the Permian peneplain, the younger mid-Tertiary plain frequently merges with the ancient surface.

Near Mt. Aigoual, central Cevennes, evidence of an ancient glaciation has been found in the form of tillite and striated bed rock. The tillite is characteristically, physically, and lithologically hete-

rogeneous and is firmly consolidated wherever it has been recently uncovered. The stones found in the matrix vary in size from very small pebbles, to large boulders more than a meter in diameter. The larger boulders are predominantly of gray granite porphyry originating in the immediate vicinity. They are rarely striated. The stones less than a foot in diameter are not always typically glacial in form, but they are almost invariably well striated.

The scarcity of glacial phenomena usually abundant in regions of Pleistocene glaciation, and the absence of the topographic situations where alpine glaciers could have formed, indicate that the tillite in question is considerably older than Pleistocene. The peculiar location of the glacial evidence in certain mature valleys, which physiographic investigation shows to be of mid-Tertiary age, has led to the conclusion that the glaciation occurred before the close of the Miocene time. The glaciers that left the tillite must have been mountain glaciers originating in the Oligocene or early Miocene mountains which are known to have existed in the region following the uplift and faulting that took place during the Oligocene time.

Following the mid-Tertiary era, the region of the Causses and Cevennes has been subjected to rapid dissection in the areas of impermeable rocks and to karstification in the limestone areas. This dissection, still in progress, results in the cutting of great gorges and the development of karst topography.

I. BATSCHELET (Introduced by Helen M. Strong).

Geographical Work in the Bureau of the Census.

1. Scope of the census.
2. Use of maps in census taking.
3. Units for which census data are available.
4. Use of maps for interpreting census data.
5. Conclusions.

NELS A. BENGTSON

Notes on the Physiography of the Southern Maracaibo Lowland of Venezuela.

The structure of the Maracaibo Basin has not been determined in detail. Some have held that it is a *graben,* others that it is a normal trough characterized by geosynclinal structure, still others that it is a faulted syncline. To the writer the evidence seems to indicate a broad synclinal depression where there has been pronounced faulting along some edges, but this is neither dominant nor effective enough to justify the use of the term *graben.* Intense

faulting is apparent in the southern sector southeast of Tachira and also in some places in the north, but elsewhere the down folding seems to be quite normal and attended only by moderate faulting. In the southwestern quadrant of the basin are numerous structural ridges, some of which are large and some small; Oro, Tarra, Buena Esperanza, La Paz and Concepcion being examples. These all show the effect of strong compressional forces, so it seems clear that the tectonic processes which have given rise to the surrounding mountains and have dominated the margins of the present basins have produced a depression of complex type. The sediments formerly lying nearly flat have been folded and somewhat faulted to become of less lateral extent than was originally the case and hence the present dominant structure of the basin is that of a broad synclinorium with major axis extending north and south.

The topography is characterized by flats surmounted in places by ridges or low hills. These elevations, so far as studied, indicate structural origin. It is reported that the lake bottom shows similar relief and that more than thirty high spots are known for which dome structure is assumed.

The Maracaibo Basin is deeply underlain by sediments of Tertiary and Cretaceous age which are overlain unconformably in the extensive flats by beds of Quaternary and Recent gravels, sands, and clays. The evidence indicates that on the whole the percentage of sandstone is greater in the Tertiary of the western part of the basin than in that of the eastern part. In the eastern portion great thicknesses of carbonaceous shales have been found which have no counterpart in the west. On the other hand the heavy Mirador Sandstone which is recognized as a well-marked constant in the southwestern part of the basin, reaching there a thickness of nearly one thousand feet, appears to have no equivalent in the eastern sectors. Upper Cretaceous shales of great thickness underlie the entire basin.

The paper presents a detailed discussion of the physical features of the District of Colon in the southwestern part of the Basin accompanied by a map based on field work which shows the correct location of the ridges, flats and basins of the area.

H. H. BENNETT.

The Problem of Soil Erosion.

The problem of land depreciation by man-induced erosion is of national importance. Normal erosion is not necessarily harmful,

since it proceeds slowly and permits the development of mellow topsoil. Without it the world might be overstocked with infertile laterites and poorly drained claypan soils.

The gap between the geologic norm and the accenuated erosion resulting from man's cultural operations is too wide over most of the upland soils of the United States. Even burning off a moderate cover of forest-litter starts erosion and increases runoff. When timber or grass is removed and the land plowed, large areas lose their topsoil, in the course of 25 to 75 or 100 years, due to continuing sheet erosion. The Shelby loam of the Corn Belt is losing soil from the average slope, where used continuously for corn, at the rate of a 7-inch layer in 49 years, compared to about 3,000 years where the land is well sodded with bluegrass. Measurements of runoff and washoff indicate that not less than 75% of all the cultivated land of continental United States is suffering from erosion. In some major farming regions more than 90% of the cultivated land of some counties is being impoverished by sheet erosion. The average field used continuously for cotton in rolling sections of the Black Belt of Central Texas is losing its entire surface soil in 35 to 45 years.

The average topsoil depth of a large number of representative upland samples, collected from 34 states, is 9 inches. When removed, the material left frequently consists of clay, more difficult and costly to till, less absorptive of rainwater, quicker to dry out in drought, and readily gullied. Although many million acres have been ruined and abandoned because of gullying, sheet erosion is the most damaging form of soil washing.

Overgrazing on the western ranges starts erosion on sloping uplands and on many alluvial plains, where deep channels have been cut through flats which 50 or 60 years ago were well grassed.

The proportion of the products of erosion stranded *en route* to sea is much greater than that which enters the oceans. It comes to rest over alluvial plains, in stream channels, reservoirs, and ditches. While some refreshens crop lands, much is deposited over productive soil, and, if sand or gravel, injures the land. The variables affecting the rate and kind of washing include soil character, amount of rainfall, intensity of individual showers, slope, kind and density of vegetation, and land use.

The national program for erosion control, started two years ago by the Department of Agriculture, coöperating with the states,

calls for the establishment of erosion and water conservation experiment stations in 20 or more major erosion regions.

DANIEL BERGSMARK (Introduced by Nevin M. Fenneman).

Clermont County—Economic Adjustments to the Environment.

[Read at the Columbus Meeting, December, 1929.]

Located immediately east of Cincinnati, Clermont County has a favorable situation for economic growth. It extends 33 miles from north to south, 16 miles from west to east, and embraces 465 square miles. Bounded on the south by the Ohio River, the county contributes its mite to the stream of traffic on this major inland waterway. With a frost-free season of 173 to 200 days and mean annual precipitation of 40 inches, it lies within the Corn and Winter Wheat Region of North America, where corn and winter wheat are the dominant grain crops in the rotation. Its location in the Till Plain along the southern margin of the old eroded glacial drift is reflected in a paucity of moraines and lakes within its borders. But this plain has been dissected in some places, and the larger streams have cut valleys from 200 to 400 feet deep, leaving a land surface composed of level and rolling interstream areas, valley slopes, and valley bottoms, with their different environmental conditions for agricultural production.

Cultural and natural features of the southern Ohio landscape are present in contrasting and multiple forms in Clermont County. Level, poorly drained uplands almost devoid of forests and devoted chiefly to the production of hay, corn, and small grain, stand in sharp contrast to steep-sided, heavily-wooded valley slopes containing small scattered patches of cleared land, which is given over to pasture, orchards, tobacco, and corn. Rolling uplands devoted to a variety of field crops as well as fruits and vegetables offer equally striking contrasts to the alluvial soils on which the single crop, corn, occupies more than 80% of the cultivated land. Thus Clermont County is areally differentiated into a number of small natural environmental units upon which may be superimposed at least on equal number of cultural landscapes.

Clermont County contains several distinct trade units or communities. Such a unit contains a trade center and its surrounding agricultural land. The size of these trade units is determined by the outward extent of influence of the village institution into the

adjacent rural areas. Much of the trade of all the communities of Clermont County is deflected directly to Cincinnati, where many of the farmers market their agricultural surplus, purchase various commodities, and seek recreation.

Clermont County contains only a few manufacturing plants, such as a machine shop, foundry, and creamery at Batavia, clothes hanger and hosiery manufactures at New Richmond, a shoe factory at Bethel and one at Williamsburg. Most of these manufactures were attracted to this area because of the cheapness of land and low wages. All but the creamery reach out to distant areas for raw materials as well as for markets.

J. F. BOGARDUS (Introduced by Frank E. Williams).
Changes in the Size and Activities of the Population of the Netherlands.

The population of the Netherlands has increased steadily during the past century, the rate of increase being most rapid during recent years. As emigration has exceeded immigration during this period this increase must have been the result of an increasing birth rate or a decreasing death rate or both. Statistics show that the birth rate increased until approximately 1870 and that it has decreased quite steadily since that time. The death rate, on the other hand, has decreased steadily since 1840 but the decrease has been especially marked since 1870. These facts indicate that up to 1870 the increasing birth rate was the most important cause of population increase while since that time the decreasing death rate has been most important.

The growth of population has not been uniform throughout the country but has varied in different provinces. The growth has also varied in communities of different sizes. In general the larger communities have increased much more rapidly than the small towns and country districts and, as in most modern countries, have drawn population from these smaller settlements.

This rapid increase of population has necessitated a readjustment in the economic organization of the country to provide employment for the constantly increasing numbers.

In agriculture this readjustment has taken the form of an increase in cultivated acreage, a more intensive cultivation of staple crops, and greater intensification through an increase in truck farming and the raising of cattle, especially for dairy purposes. These changes meant that more people were being employed in

agriculture but they were far from sufficient to provide employment for the increasing population.

The expansion in commerce and transportation and in mining also resulted in a constantly increasing number employed in these fields but again these increases were insufficient to solve the problem.

A rapid expansion of the manufacturing industry was essential to provide employment for those not provided for in the fields already considered. This increase in manufacturing has been so rapid within recent years that today it provides employment for nearly as many persons as agriculture and commerce and transportation combined.

These changes in the economic structure, caused, at least in part, by the pressure of a constantly increasing population, have changed the Netherlands from being primarily an agricultural country to one in which industry dominates.

ADELBERT K. BOTTS (Introduced by Charles F. Brooks).
The Rainfall of El Salvador.

The rainfall of El Salvador is an excellent example of west coast trade wind precipitation on the northern margin of the equatorial rainfall belt. The average annual rainfall of the country is 75 inches, an amount which we usually consider very bountiful. However, the differences over the territory, and over the period of record leave much to be desired.

The amount of precipitation varies directly with the altitude of the land, thus giving the central plateau and mountain district a considerably greater rainfall than the lower coastal regions. An exception is found, however, in the regions farthest from the coast especially in the lee of the central mountains.

The precipitation is decidedly seasonal in its annual distribution. There are four distinct seasons, each of maximum or minimum rainfall, distributed somewhat as follows:

Rainfall condition	*Season*	*Months*	*Length of season*	*Average rainfall*
Maximum	Spring	Apr., May, June	3 months	20 inches
Minimum	Summer	July	1 month	11 inches
Maximum	Fall	Aug., Sept., Oct., Nov.	4 months	40 inches
Minimum	Winter	Dec., Jan., Feb., March	4 months	Less than 1 inch

April is a month of very light rainfall, seldom averaging more than three inches. From the latter part of April the amount of rainfall increases with the northward advance of the sun. The

maximum rainfall occurs from one month to six weeks after El Salvador's spring period of zenithal sun.

July shows a distinct decline in the amount of precipitation. This minimum obviously results from lowered intensity of convection pursuant to the passage of zenithal sun to the north of the country. The sun soon turns southward so the period of reduced rainfall is correspondingly short.

The fall rainy season reaches its maximum in September. This rainy season is distinguished from the other by its greater length and intensity. The reasons for the difference are:

1. It follows the fall period of zenithal sun as the April maximum followed the zenithal sun of spring.
2. Unlike the spring period the fall follows an extended period of moderate rains which have built up a considerable moisture reserve in the soil and vegetation.
3. The period from April to November receives more insolation than the period from December to March, thus developing a summer low over the land. Air moving toward the low from the Pacific Ocean brings more moisture than is available in the spring.

The winter season is the true dry season characteristic of lands in the lee of high mountains in the trade wind belt.

ALBERT PERRY BRIGHAM.
Glacial Problems in Central New York.

The paper discusses:

(a) The movement of ice currents, earlier and later. The meeting of the Lower Mohawk ice moving westward, with Ontarian currents moving to the southeast.

(b) The alleged glacial-water channels on the north-facing Mohawk and Oneida slopes.

(c) The question of lakes held up between receding ice fronts in the Mohawk Valley; also of supposed smaller lakes in the obsequent valleys that cut the north edge of the plateau.

(d) Land forms due to glaciation, especially the drumlins, drumlinoids and glacial flutings of the plateau region.

(e) Effect on soils and agriculture, of ice crossing the succession of Paleozoic outcrops.

CHARLES F. BROOKS.

Some New Climatic Maps of the United States.

In connection with the forthcoming Köppen-Geiger *Handbuch der Klimatologie* a number of new maps to supplement the excellent collection in the *Atlas of American Agriculture* have been made.

1. Temperature distribution at sea-level, January, March, May, July, September, and November. With some 200 stations these maps portray much more closely the temperature as varying with latitude and distribution of land and water. For example, earlier maps did not bring out the striking warmth of the chinook-swept high plains of Wyoming and Montana in contrast to the cold of North Dakota in winter.

2. Actual temperature distribution, January and July. The new maps, based on a 46-year record for 200 stations are more general than the 20-year maps in the *Atlas,* but represent a more stable set of normals.

3. Mean annual range of temperature. No new United States map of this important measure of continentality has been published since 1894.

4. Average absolute maximum and minimum temperatures. We are all familiar with maps of absolute maxima and minima, each successive edition showing greater extremes, but we have not heretofore seen the distribution of the average of the highest and the average of the lowest temperatures each year for the period of record. These show much better what extremes may be expected.

5. Wind roses and sea level pressure for January and July. Pressure and prevailing or frequency-resultant wind maps have been published heretofore, but we have missed the indications of frequencies of winds from different directions.

6. Average annual rainfall. Fifty-year normals for 200 stations and other long records for 200 more form the basis for this new map. It is less detailed than Kincer's in the *Atlas,* but the rainfalls shown are closer to what may be expected in the long run than was possible from the 20-year period used for the *Atlas* map.

7. Average monthly rainfall for January, March, May, July, September, and November. These are based on the 50-year normals for the 200 regular Weather Bureau stations. They are less detailed than the *Atlas* maps, and differ from them to a recognizable degree over extensive areas.

8. Average noontime humidities, January and July. Since 1917, when humidity observations at local noon were inaugurated by the Weather Bureau, a body of data has become sufficient for fairly detailed maps of midday humidity.

9. Average cloudiness, January and July. Days clear, days cloudy, duration and per cent of the possible sunshine are all depicted in the *Atlas,* but not the average cloudiness. New Weather Bureau tables make it possible to fill this gap. The distribution of average cloudiness is not the inverse of the possible sunshine. Especially marked is the difference in the arid Southwest, where clouds are frequently thin enough to let the sunshine through.

ROBERT M. BROWN.

Water Supply in Large Cities of the United States.

I. Cities in Arid and Semi-arid Areas—Los Angeles as a type.
II. Cities in Densely Populated Areas of Humid Regions—New York City as a type.
III. Sources of Supply and Consumption.
IV. Adequacy of Supply and Conflicts in Uses.
V. Conditions of Treatment for Potability; for Purity; and for Industrial Uses.

MEREDITH FREDERIC BURRILL (Introduced by C. F. Jones).

A Field Survey of Industrial Montreal.

To properly comprehend the industrial physiognomy of Montreal, one should view it from three ways: from above, to see the strip of large-scale manufacturing along the canal, the lower port and the belt railway; from an automobile, to appreciate the abundance of moderate-scale plants in a zone lying west of the central section of the first strip; and on foot, to discover the small establishments in or around the business district and along St. Lawrence Boulevard.

Manufacturing employs nearly one third of the city's workers, as many as trade, finance and transportation combined. The fraction is increasing. Fifteen groups of products constitute, by value, 55% of the manufactures. Their variety indicates the complexity of Montreal's industrial make-up.

Montreal owes its place in Canadian manufacturing to (1) its geographical location providing ocean, river, lake, and rail transportation; cheap hydro-electric power; a plentiful supply of cheap,

intelligent, tractable labor; large, growing, domestic market; and abundant good water at low cost; (2) extensive factory sites admirably suited to a variety of industries; (3) favorable political and financial conditions; and (4) momentum of an early start. These controls operate in different degrees: (a) Railway rolling stock, a large-scale, densely concentrated, and higly integrated industry, owes its location and prominence to local market and cheap labor. (b) Flour milling depends upon the break in all-water transportation of grain to overseas consumers. Neither labor, fuel, nor power are great expense items. This large-scale industry is concentrated in a few mills and in a few places, but only slightly connected with other manufacturing. (c) Sugar refining depends upon cheap transportation of materials and fuel and upon a broad Dominion market. Labor and power are unimportant. Operations are concentrated in a few huge plants moderately integrated with other manufacturing. (d) Cheap labor and local markets attract the textile industry. This moderate-scale, moderately concentrated enterprise supplies many local manufacturers. (e) Women's factory clothing is produced by cheap labor in the major market. The industry is concentrated in small unintegrated shops, clustered in one section of the city. (f) Cheap labor, cheap power, local market, an early start, and French enterprise explain the many shoe factories. Other related industries in the district supply materials. (g) Cigars, cigarettes, chewing and smoking tobacco have in common dependence upon cheap labor, indifference to fuel, power, and local raw materials or market, and self-sufficiency. They differ in regional concentration and scale of enterprise. Cigars are manufactured in small scattered establishments; other products are made in a few large plants. (h) Portland cement is about the only industry dependent upon fuel and local raw materials. Water transportation provides the fuel at low cost. The industry is conducted on a huge scale and at only a few places in Canada.

PHIL EDWARDS CHURCH (Introduced by Charles F. Brooks). *The Temperatures of New England.*

In New England there is a much greater difference in the mean winter temperatures from north to south than in mean summer temperatures. From northern Maine to southern Rhode Island and Connecticut there is a difference of 18° F., while in summer the difference is but 8° F. Altitude can account for but one degree as the difference in elevation is but 400 feet. Thus, in winter

there is an exceptionally steep gradient amounting to about 2.8° F. for each degree of latitude, due in part to the influence of the large land mass to the west and northwest. In the summer the gradient amounts to about 1.1° F. for each degree of latitude, which is somewhat more than in the Mississippi Valley. The ocean influence is pronounced in the winter, the coasts being kept some 5° F. warmer than the interior. In summer the contrast is opposite, for the coastal temperatures are from 2° to 4° F. lower than those 20 or more miles inland, which lie beyond the usual penetration of the sea-breeze.

Killing frosts may be expected in northern Maine and the highlands of New Hampshire and Vermont as late as June 1st. In Rhode Island and the Cape Cod region the last occur about April 21st. Here the latitudinal difference of five degrees should make the season earlier by about 20 days and the lower altitude 4 to 10 days more. There is still a remaining seasonal difference of about two weeks which may be ascribed to the effect of the ocean. In autumn the oceanic retardation of the first killing frost is still greater. In Provincetown the first killing frost, on the average, comes after November 1 while in Taunton, but 25 miles inland, it comes about October 1, both being in the same latitude. In the spring the last killing frosts are but 10 days later at Taunton than at Provinceton.

The influence of the ocean on the temperatures is best seen in the length of the growing season and the mean annual range. All along the coast there is a growing season of at least 150 days while inland it shortens to less than 100 days in northern Maine. Cape Cod has a growing season of more than 190 days while Taunton has less than 140.

The mean annual range amounts to 37° F. at Nantucket and 58° F. in northern Maine. Even a few miles from the coast the annual range amounts to about 45° F. while farther inland it rapidly becomes greater.

CHARLES C. COLBY.

Centrifugal and Centripetal Forces in Urban Geography.

This study attempts to recognize, describe, and classify the centrifugal and centripetal forces which profoundly affect the development of urban areas. The centrifugal forces are defined as those under which certain urban functions migrate from the central zone of a city towards or actually to its periphery, while the centripetal

forces are those which attract other functions to the central zone or hold them there.

The classification of forces is made on the basis of evidence drawn from twenty-two representative cities; fifteen in the United States, four in Canada, and three in Great Britain. Cases of centrifugal and centripetal migration were tabulated, the centrifugal column showing fifty-six items and the centripetal column forty-four. Many examples were recorded under certain of the items, and this fact differentiated the more important from the less important items. It is hoped to continue the investigation to include many more cities, and thus the present study is in the nature of a reconnaissance and the suggested classifications extremely tentative.

According to the thesis, the centrifugal forces are made up of a combination of uprooting tendencies in the central zone of a city and the attractive qualities of the periphery. These tendencies and qualities were analyzed into their component parts, and subsequently the components of a similar kind or quality were classified. This classification led to the recognition of the following five centrifugal forces: (1) the *spacial force,* under which congestion in the central zone uproots and the idle land of the periphery attracts; (2) the *site force,* under which the greatly modified natural landscape of the central zone is balanced against the relatively unchanged natural landscape of the periphery; (3) the *force of efficient functional performance,* under which such conditions as high land values and high taxes create the urge to move, and cheap land and low taxes represent the invitation to come; (4) the *organization of occupance,* in which the competition of functions, and the tyranny of the past in the long established central zone stand in opposition to opportunity for controlled conditions in the newly developed periphery; and (5) the *human equation.*

The centripetal forces in urban development focus on the central zone of a city and make that zone the center of gravity for the entire metropolitan area. In this central zone, the number and complexity of urban functions increases enormously, and the functional forms become extremely complex. Land values range high, in harmony with the intensive use of land. Such value and use indicate that the central zone possesses extraordinary assets. These assets are the centripetal urban forces and are classed into the following five groups:

1. *Gravitative attraction of central position.*
2. *Convenience in functional performance.*

3. *Functional magnetism.*
4. *Functional prestige.*
5. *The human equation.*

G. E. CONDRA.

Development of the Platte River Bottomland in South Central Nebraska. (Published in full in this issue.)

GEORGE B. CRESSEY (Introduced by W. Elmer Ekblaw).

The Distribution and Origin of Chinese Loess.

Previous theories of the origin of Asiatic loess have been developed without detailed study of its distribution. The principal contribution of this paper is an isopleth map showing the thickness of the loess in the area of northwest China where it is best developed, namely between the Tsing Ling Mountains on the south and the Great Wall on the north. The concentration of the loess to the south and east of the Ordos Desert suggests that this region was the principal supply area, rather than the Gobi proper. This condition may have been due to a now extinct lake in the Ordos basin into which the Hwang Ho discharged its burden of silt. With the draining of this lake abundant supplies of fine material would have been available to the wind. Such an hypothesis is supplementary to the usually accepted desert origin of the loess. A secondary area of loess along the south bank of the Yangtze Kiang near Nanking is attributed to river silt blown up from the flood plain of the river.

STANLEY D. DODGE (Introduced by K. C. McMurry).

Bennington, Vermont: a Geographical Study of Urban Growth.

There are three distinct phases to the growth of Bennington, Vermont, when that growth is considered geographically. The original settlement was made on a commanding hill, easily defended, at the foot of Mt. Anthony. Thence the town spread eastward, so that now the main commercial and industrial portion of the agglomeration occupies the alluvial fan of the Walloomsac River, where that river debouches from the Green Mountains. At the present time there are indications of a northwestward spread towards the more strategic commercial site of North Bennington.

FRANCES M. EARLE (Introduced by J. Russell Smith).

The Mechanization of Agriculture in U. S. S. R.

The grain problem is the keynote of the Russian economic situation. The reorganization and mechanization of agriculture is

essential to the success of the Five Year Plan. Industrialization is closely related to expansion of foreign trade which is dependent largely upon an exportable surplus of agricultural products. In order to replace the pre-war marketable surplus of grain produced by kulaks and landlords and to increase the volume of exports, the Government created large soviet and collective farms. The mechanization of extensive areas has increased output and reduced cost of production by economies of large scale methods. As yet sixty to seventy-five per cent of peasants are individualist farmers; it is expected ultimately that production on individual farms will be superseded by state and collective farms.

Rapid industrialization of agriculture creates many problems but the Russian plains present an ideal location for an experiment in the application of modern science, modern machinery, and mass production to agriculture.

W. Elmer Ekblaw.

The Importance of Solifluction.

Solifluction, the slow movement of detritus under arctic and subarctic, and postglacial, conditions, has not been adequately recognized.

Over large areas in Greenland and Alaska it forms a major physiographic agency in the transportation of surficial materials, whether the slope be steep or gentle. Wherever melting snow, rather than rain, constitutes the chief source of surface water, and where frequent freezing and thawing are common, the action of solifluction is important.

Solifluction has likewise been important in the same way during postglacial times in regions no longer subarctic in character, where many polar conditions of climate prevailed during the time of the continental glacier and its disappearance, and where revegetation required the lapse of considerable time. Evidences of solifluction seem clear and widespread when recognized as due to this agency.

W. Elmer Ekblaw.

Russia Today.

Russia today is essentially the Russia of yesterday and the day before, despite the change from Czarism to Communism. The same physical factors are working today to make difficult living conditions over most of Russia as have operated throughout history.

The proportion of arable land cannot be significantly increased. Even under Communism, granting that it may be the best government possible, nearly the whole northern half of Russia can support only a slightly larger population than it does today, and very little of the semi-desert steppes in the southern half, not now under cultivation, can be made to support a successful field agriculture. The wedge of successfully cultivated land abutting upon central Europe and tapering to a point near Semipalatinsk is actually fully peopled today—perhaps overpopulated!

The important parts of the Soviet five-year plan seem impossible of achievement; the education to literacy of almost a hundred fifty million people, the industrialization of a nation fundamentally agricultural and pastoral, the substitution of materialistic theory for theistic religion in innately devout races, cannot be attained in a century, not to say half a decade, if the criteria of past history can be applied.

CHARLES B. FAWCETT (Introduced by W. W. Atwood).
The Nordic Region.

The part of Europe here called the Nordic Region is usually divided between at least two of the major climatic regions and three or more of the major physiographic regions. It is the purpose of this paper to examine its real geographic unity as a single major cultural region.

It will be considered in its physical aspect, as the coastlands of the shallow transgression seas of northwest and north Europe, its location, and the climatic and vegetational characters which influence its cultural development.

Racially it is the home of the Nordic peoples, and its cultural identity rests on that and on the following facts, each of which will be traced briefly.

a) It is the northern area which was outside the Romanized provinces of the Roman Empire, and hence is north of Latin Europe.

b) It is the region of the Low German linguistic group.

c) It is the area of origin and development of the individualistic type of society—a form of social and political organization which originated only here.

d) It is also the home region of the Protestant forms of Christianity—a fact parallel to (c) above.

Its border zones are all transitional areas, and it is one of the chief nodal areas of major world routes. Hence its identity does not rest on any sharp divisions from its neighboring regions. It is one of the most distinctive and important cultural regions of Western Civilization.

EDITH M. FITTON (Introduced by Charles F. Brooks).
Soil Temperatures in the United States.

By writing to all of the State Agricultural Experiment Stations and examining all of the available literature on the subject, soil temperatures for 26 stations, well scattered over the United States, have been obtained.

The data came in many different forms—published material, manuscript graphs, original thermograph records, letters from experiment station officials. The experiment stations, being mainly interested in the effect of temperature on an important local crop, frequently placed the thermometers at the depth at which the seed would be planted. Depths therefore vary considerably, as do also the periods and seasons of observation, the kinds of soil and soil cover, and the exposures. While the data are not strictly comparable from station to station, the records at individual stations point to some interesting conclusions, especially when data for different depths, kinds of soil, or exposures are recorded at a single station.

A study of the tabulated records and graphs indicates the following major conclusions:

(a) Air and soil temperatures near the surface vary in a fairly parallel manner.

(b) In all cases, the soil temperatures at slight depths are higher than the air temperatures throughout the year.

(c) The diurnal range in soil temperature extends to a depth of about three feet.

(d) The annual range in soil temperature is quite apparent at a depth of 10 feet, the greatest depth for which a record is obtainable in the United States.

(e) The lag of maximum and minimum soil temperatures increases with depth.

(f) A cover crop lessens the diurnal and annual temperature ranges.

(g) In the winter time, northerly stations where the snow cover is more or less permanent show higher mean monthly soil

temperatures than stations somewhat further south or west but lacking a good snow cover.

(h) The presence of moisture in the soil tends to give a low and uniform temperature.

(i) Loam, clay, and peat soils never become as warm in summer as the drier gravel and sand soils.

(j) Soil temperature and range decrease with altitude.

(k) South exposures at any altitude have higher temperatures and a greater range than north exposures.

W. H. HAAS.

The Mississippi River, Asset or Liability.

The economic geographer is interested in the removal of handicaps that prevent the free play of productive forces. To warrant any changes, however, expenditures most be looked upon as investments for which there is a reasonable certainty of yielding adequate returns. The northern interior is handicapped by its inland position and looks to the Mississippi for relief. The southern interior likewise suffers from a lack of adequate transportation, as also from recurring floods. Is the development of the Mississippi as an economic unit the solution? Can it be made into a great regional asset or may it become a growing national liability?

ROLAND M. HARPER.

Geographical Variations in Longevity.

One frequently sees statements in print about the average length of human life in the United States, and how it has increased in recent decades, but there is seldom any intimation that it might not be the same all over the country. Some such data for different states and cities are available for 1920, however; and the writer has recently been investigating the matter in Georgia, Florida and Alabama by means of dates on tombstones, and has found some interesting variations.

In most cemeteries that go back far enough, the average longevity of white people in the middle of the 19th century has been found to be not far from 30 years; but since then some communities have made more progress than others. In any city the most rapid increase, generally speaking, has taken place since the installation of waterworks and sewers.

In one Georgia city which is in a malarial region the average longevity for white people in 1880 was only 20 years. The first

successful artesian well in Georgia was drilled near there in 1881, and the average longevity is now 52 years; having more than doubled in half a century. However, in another city only 35 miles away, but in a non-malarial region, the average longevity of whites at the present time is only 42 years. And in another Georgia city there is a difference of about seven years on opposite sides of a river which flows through the city.

So these differences may be due to heredity as much as to environment. But in either case, they afford one more factor to be considered in studying the human geography of any state or other area. There are also significant differences between different strata of society in the same community, as can be demonstrated in some localities, but a study of those is probably outside the field of geography.

A graph is exhibited, showing the average length of life for white people in several different communities from the present time back as far as available records go. Some possible sources of error are of course recognized, but they need not be discussed at this time.

WM. H. HOBBS.

Aerological Work in Greenland.

To some extent coördinated meteorological and aerological stations are now set up in Greenland. Three stations of the German Expedition commanded by Dr. Alfred Wegener near latitude 71°; two stations of the University of Michigan operating under a grant of the Carnegie Institution of Washington on the Greenland west coast at Camp Irving Scott in latitude 72° 51′ and at Ivigtut in latitude 61°; and a station of the Norwegians on the east coast in latitude 73°; are all, it is my belief, now carrying out regular daily pilot balloon ascensions. In addition the stations of the British Arctic Air Route Expedition near latitude 66° in southeast Greenland are conducting meteorlogical studies. It is expected that all these stations will be in operation for the greater part of a year, and they should give us new information as to the correspondence of out-flowing winds from the Greenland interior.

ELLSWORTH HUNTINGTON.

A Cross Section of Northern Africa.

A cross section of North Africa from the mouth of the Nile to Lake Victoria and Kenya is particularly interesting because it provides some of the most extreme examples of various geographical

types. For example, almost nowhere else is the irrigation type of life more fully developed. Nowhere else has it continued so long without interruption and probably nowhere else has the necessity for patient steady work so completely weeded out the people who do not conform to the physical and mental type adapted to such work.

Farther south in Sahara we have an example of the most extreme kind of desert where there may be no vegetation for 100 miles at a time even though the soil is excellent. Then come the grass lands of the Sudan. In these the Nomadic plundering type of life has reached as high a development as in Arabia with almost identical results. The ability of the idle Nomadic type to dominate hardworking new-comers is very striking. Equally striking is the extraordinary development of grass as a type of vegetation. The effect of a short but very intense wet season followed by a long and very severe dry season is clearly seen in the concentration of people along the rivers and in the extraordinary absence of people elsewhere even though the vegetation appears luxuriant.

Among the native people of the Sudd still farther south we appear to have an extreme illustration of the effect of heat. Life is reduced to the simplest terms because there are practically no needs except those of food. A few degrees farther south and at a higher elevation the rather highly civilized banana eating people of the plateau present a curious contrast to their neighbors farther north.

The final type in this cross section is the white immigrants in the high plateaus of Kenya where they are intermingled with savages and Hindus in a way that produces some extremely complicated problems.

MARK JEFFERSON.

The Distribution of Urbanization.

A percentage of urban population has been computed for many countries but on a variety of city bases, the city being taken at 500 people in Ukraine, 11,000 in Egypt, and 24,000 in Japan, and many values in between. These percentages are not comparable and cannot be used except to compare countries that use the same definition of city.

This paper selects the Great City (100,000 inhabitants) as the standard of urban life, for several reasons. Life in them is really urban, which life in towns of from one to five thousand is cer-

tainly not. The data for these cities are readily obtained in all parts of the world, and the growth of cities that has characterized the last century was mainly in cities of considerable size.

With urban thus defined we find that nearly half of the Australians and English (not *British*) live in such cities, a third of the New Zealanders and Austrians and more than a quarter of the people of the United States, Netherlands, Germany, Canada, Argentine and Uruguay; of the Japanese 14%, of the Chinese and Indians about 2%.

These cities are modern. Their number has been doubled four times over in the last 125 years. The origins of such cities is European but they are now more numerous out of Europe than in that continent. In the United States the last century saw a regular succession of cities come to 100,000 size, first five ocean ports, then four river ports, five lake ports and lastly, from 1850 on, almost a new railway city every year. Europe had no such succession. She had all the great cities that were known in 1800, some of them ocean ports, some river ports and two grew to great cities by reason of their posititon at the crossing of land ways. In the second half of the century railways took up the transportation called for by great city life but the rivers and highways have already been of much use in Europe and continue so at the present time.

In studying the results we come on the regrettable fact that the census numbers for great cities are only for their sleeping moments, and at times omit large numbers who yet spend in them all their waking, working moments. The city in which we are interested is awake and at work. We need to know how many go in to cities daily for their active avocations.

W. L. G. Joerg.

A Note on the Numerical Distribution of the Population of the World According to Climate.

The fundamental importance of climate among the elements constituting man's physical environment makes it desirable to know how the population of the world is distributed among the different types of climate. Possibly the most feasible way to determine this is to calculate the number of inhabitants living within the areas indicated on a world map of climatic provinces. Although the resulting figures will necessarily be approximate, owing to the subjective nature of every classification and the discrepancy be-

tween the political units of census figures and the physical units of the climatic map, they will nevertheless be sufficiently accurate for a broad general survey.

For the present experimental evaluation none of the standard world climatic maps obviously call for first consideration, such as de Martonne's (1:100,000,000, revised edition, in his *Traité de géographie physique,* 4th edition, Paris, 1925) or Köppen's (1:60,000,000, *Petermanns Mitt.,* Vol. 64, 1918, or 1:20,000,000 as elaborate wall-map edition jointly with Geiger, Gotha, 1928) was selected, owing to their complexity. Instead, a map with simpler and more compact areas, viz. Griffith Taylor's map of the major economic regions of the world (1:200,000,000, *Geogr. Rev.,* Vol. 12, 1922, p. 378, and 1:260,000,000 in his *Environment and Race,* London, 1927, p. 321) was used. Although termed economic regions these areas are closely akin to climatic provinces, inasmuch as temperature and rainfall are the dominant criteria of subdivision and the regions are based on Herbertson's natural regions. Furthermore there is the practical advantage that Taylor has calculated the economic value (in the form of an "econograph") of all the 74 regions of his map and the potential saturation population of the leading 14 regions available for settlement by the white race and that hence comparative figures are already at hand for which the figures of present population (which are not given by Taylor) may serve as a background.

Taking as a basis the estimates of the 1928 population by the International Statistical Institute (*Aperçu de la démographie des divers pays du monde,* The Hague, 1929, pp. 2-52) the total world population of 1,937,000,000 is distributed as follows among Griffith Taylor's regions (as listed in decreasing order of economic value within each continent, *Geogr. Rev.,* Vol. 12, pp. 394-395, and *Environment and Race,* pp. 322-323); figures represent millions, less than half a million counting as zero: *Europe:* British Isles 44, Franco-Prussia 115, Poland 128 (?), Central Russia 91, Mediterranean (including Asiatic part) 106, N. Russia 9, Norway 4, Tundra 2; *Asia:* N. China, 179, Japan 82, S. China 269, N. India 213, Siam 52, Manchuria 20, W. Siberia 4, Ceylon 5, Deccan 83, Persia 26, E. Siberia 4, East Indies 80, Aral 9, Altai 1, Tibet 4, Tundra 1, Arabia 18, Tarim 1/2, Thar 4; *Australia:* Victoria 2, E. Coast 2, New Zealand 2, Tasmania 1/2, Swanland 1/2, Queensland 1, Lachlan 1/2, N. Coast 0, S. Arid 0, New Guinea 1/2, N. Arid 0, [Oceania 1]; *Africa:* Natal 2,

Transvaal 3, Cape 3, Rhodesia 13, Madagascar 4, Algeria 14, Congo 35, Uganda 15, Sudan 21, Kalahari 1/2, N. Sahara 17, S. Sahara 13; *North America:* N. E. States 77, Inland Plains 5, Alberta 2, Utah 1, S. E. States 29, E. Canada 9, Oregon 6, S. Rockies 2, British Columbia 2, Central America 18, West Indies 9, S. California 1, Tundra 0; *South America:* Uruguay 24, S. Chile 1, W. Argentine 2, Central Chile 3, Andean Plateau 11, Colombia 9, Central Brazil 14, Brazil 8, Amazons 4, N. Chile 1/2, Patagonia 1/2.

The present investigation is avowedly experimental; but it would seem to indicate that a refined and critical calculation based on, say, Köppen's climatic provinces would yield truly fundamental values in the field of population distribution as related to climate. (In Penck's basic paper on the potential population of the world [Albrecht Penck: Das Hauptproblem der physischen Anthropogeographie, *Sitzungsberichte der Preuss. Akad. der Wiss.*, Berlin, Vol. 22, 1924, pp. 242-257] he makes use of Köppen's 1918 classification but gives figures only for potential, not present, population and arranges them according to the eleven climatic types into which the eighty-odd provinces of that classification are grouped and not according to the provinces themselves.)

DOUGLAS W. JOHNSON.

Shore Platforms of the Pacific and Their Significance.

Narrow shore platforms cut in rock and now found from one or two feet up to six feet or more above ordinary high-tide level have widely been interpreted as evidence of a recent world-wide drop in sealevel. Illustrations of such benches from the shores of Australia, New Zealand, Japan, the Hawaiian Islands and California, are shown, and several possible theories of origin are briefly discussed. Special attention is given to the hypothesis that the benches were cut by surf action under present conditions of sealevel.

WELLINGTON D. JONES.

Field Mapping of Residential Areas in Metropolitan Chicago.

A report on an experiment still in progress. Details of residential "forms" rather than of residential "functions" were recorded on the map, since the former are more readily observable in the field, and the latter are in high degree inferable from the former. Form elements selected for mapping in combination were: front

spacing of buildings (six classes), type of structure (house or apartment; seven classes), materials (two classes), upkeep of buildings and grounds (four classes). At the beginning of the experiment each separate establishment was recorded on the map by means of four digit numbers; subsequently, each block was generalized; finally, traverses were run along streets one quarter mile apart, with one-digit numbers employed to show nine types, each composed of a particular combination of form elements, as follows:

1. Large or medium sized houses, of excellent upkeep, widely spaced.
2. Large or medium sized houses, of excellent upkeep, not widely spaced.
3. Apartments, except two stories, not of wood, of excellent upkeep.
4. Mixtures of 2 and 3.
5. Houses or apartments of poor upkeep.
6. Houses not specified above.
7. Apartments not specified above.
8. Mixtures of 6 and 7.
9. Subdivisions, vacant or with only a few scattered houses (less than one tenth of the lots occupied).

So far as this experimental study has progressed, these types, recognized on the basis of form elements, appear to differ in functions, at least in affording housing to (a) unit groups of different sizes, (b) populations of different density per unit ground area involved, and (c) groups with different demands as to luxury.

Two map scales were tried, 1:6,000 for the more detailed record, 1:24,000 for the more generalized record.

While undoubtedly subject to modification in detail with further use, some such scheme as that outlined possesses the virtue of compelling as well as facilitating systematic observation, and it gives an objective and quantitative record as a sound basis for further study of urban land occupance and use.

LESTER E. KLIMM (Introduced by Frank E. Williams).
The Geographic Basis of Population Changes in Three Massachusetts Counties.

The region embraced in Hampden, Hampshire and Franklin Counties, Massachusetts, includes the Connecticut Valley lowland

in the center and glaciated hill country toward its eastern and western margins. The topographical, soil, and locational differences in its various parts have caused a variety of responses to the historic, social, and economic changes.

Where the combination of transverse valleys and Connecticut River lowland have given especially favorable transportation and power conditions, the growth of manufactures has caused twenty-two of the seventy-five towns of the area to experience considerable and rapid growth.

Five of the towns lying almost entirely in the lowland, possessed of fertile soil, and lacking advantages for manufacturing, have experienced population increase, decrease and rise again. Their population curves follow very closely the fluctuations in the prosperity of the tobacco and onion industries which are their principal reliance.

Twenty-five towns, located in the stony uplands far from good transportation, have suffered marked and continued losses in population. Contrary to the common belief, some of these towns started to lose population as early as 1800 and most of them reached their peaks and started to decline before the coming of the railroad in the 1840s. Since that time each change in the mode of transport and each discovery of good land elsewhere has aggravated the disadvantages of their location and their soil.

Twenty towns, located in regions that are neither characteristically lowland nor upland, have had a great variety of population history. In most cases they show erratic fluctuations depending on the prosperity of some single manufacturing plant.

ALEXANDER MCADIE.

The Commercial Importance of Fog Control. (Published in full in this issue).

F. E. MATTHES.

How the Mississippi Came to Break Through Crowleys Ridge.

Crowleys Ridge is a narrow strip of upland 100 to 250 feet in height that projects from southern Illinois southwestward for a distance of 200 miles into the Mississippi embayment in the Coastal Plain. Originally the Mississippi flowed through the lowland west of Crowleys Ridge, but it now cuts across the ridge at Thebes, Ill. (where the ridge begins), and thus joins the Ohio in the eastern lowland, fully 200 miles north of the former point of confluence in southern Arkansas.

The Mississippi's path across Crowleys Ridge consists of a narrow gorge cut in part in hard Paleozoic limestone, in part in less resistant Tertiary sediments. The river there has a rock channel. About 10 miles to the southwest of the gorge, in southeastern Missouri, Crowleys Ridge has been breached by the river over a stretch of 9 miles, but, although this great breach was cut fully as deep as the gorge at Thebes, it has been abandoned by the river. Still farther to the southwest are two minor gaps now traversed by the Castor River and St. Francis River respectively, which come from the Ozark region.

The diversion of the Mississippi through these several gaps in Crowleys Ridge was brought about not, as has been supposed, by successive captures effected by small pirate streams tributary to the Ohio, but by overflow, essentially simultaneously at all points, during the Pleistocene epoch, when the Mississippi had aggraded its valley with glacial sediments to a level high enough to permit its swollen waters to spill through the saddles in Crowleys Ridge. Remnants of high terraces indicate the level attained by this aggradation. The spillways across Crowleys Ridge consisted originally of northwestward draining valleys that had been beheaded by the progressive paring away of the southeastern margin of the upland by the Ohio River, which at that time flowed across southern Illinois, through the valley now occupied by the Cache River.

The abandonment of the 9-mile breach as well as of the old Mississippi Valley along the west side of Crowleys Ridge is explained by renewed aggradation following the period of degradation during which the gaps were deepened.

The history of these remarkable drainage changes at the head of the Mississippi embayment is outlined.

ELIOT G. MEARS (Introduced by Helen M. Strong).

The Geography of Economics.

An undiscovered field of exploration in the social sciences is the interrelation of geography and economics. The present situation reflects the late development of the social sciences in contrast with the exact sciences, hence a most promising opportunity exists for the careful research worker competent in both these fields of knowledge. While there are unusually few students who have had the chance and inclination to supplement thorough training in one subject with a proven ability to generalize in related fields, it must not be for-

gotten that the greatest technical and social advances in civilization have come frequently from the bold examination of the mid-zones.

The influence of geography upon economics has been neglected to such an extent that the writer has been unable to locate any treatise in political economy which makes more than a passing mention of the geographical stage where all of man's activities must occur and recur. A perusal of the standard textbooks and other accepted literature reveals practically no mention of leading geographical influences such as temperature, moisture, soil, topography and exploration. Maps are exceedingly rare. Practically never is a geographer cited as an authority on any topic.

The chief contribution to the study, generally referred to as economic geography, commercial geography, or human geography, has come from recognized geographers. Similarly, it is most uncommon for this group of scholars to cite as authority leaders in economic thought. However, one may account for the unnatural bridge between the frontiers of economics and geography. The facts are clear that the venturesome economic traveller attempts to cross to the geographical side without either exhaustive information or an adequate appreciation of the geographical viewpoint. Is it any wonder, then, that his journey is undertaken without the greatest advantages to himself and his fellows, and under the circumstances it is obvious that the two can never meet in a joint understanding. A similar situation is true of the traveller of geography.

Geographical economics, a term which I have devised as capable of contraction into geo-economics, is the virgin challenge to the political economist. In contradistinction, economic gegraphy is geography and not economics. Research in both fields, that is whether approached from the standpoint of economics or geography, can be correlated to distinct mutual advantage in helping to explain the complex relations of organic life in its natural environment.

A. E. PARKINS.

The Water Power of the Southern Appalachian Region.

The South as a whole has only 13% of the potential water power of the United States, yet it has 28% of the developed power or 3,875,000 horsepower. More than 2,600,000 horsepower are generated on the South Atlantic rivers in North Carolina, South Carolina, and Georgia. Nearly all the developed sites in the South are on the Piedmont and in the Southern Appalachian Mountains

(the Blue Ridge Province). The natural environmental conditions favoring power development are the great fall of the streams; the presence of numerous rapids and shoals, which shows a lack of adjustment to unequal hardness of the rock; the heavy rainfall, well distributed seasonally; and large tracts of mountain forests—mostly in National Forests—at the headwaters of the streams. Added to these are numerous favorable sites for the construction of lowcost dams; cheap overflow lands; a ready market—5,000,000 spindles, about 1/7 of the spindles of the country are turned by water power supplied by one public utility company; enterprise and available capital, both Southern and Northern; and the development of an extensive network of high-power transmission lines.

In comparison with power developments in the North, two characteristics of Southern power projects are outstanding: The large capacity of some of the plants—90,000, 108,000, 135,000, 188,000, 234,000 horsepower are the figures for some of the larger, while outputs of 50,000 to 100,000 are common; and the high head under which some operate, heads of 75 to 150 feet being common. At Tallulah Falls, Georgia, the plant operates under a 608-foot head, at Waterville, North Carolina, a 755-foot, and a storage reservoir and power plant now under construction on the Nantahala River, North Carolina, will produce a head of 950 feet. Reservoirs at some of the giant power projects are modifying the landscapes materially. Lakes 25 to 50 miles in length with shore lines of 200 to 500 miles are being created at some developments.

ROBERT S. PLATT.

Pirovano: Items in the Argentine Pattern of Terrene Occupancy.

This field study has to do with a tract of land 200 miles inland from Buenos Aires, a fragment of the region academically called "the Moist Pampa," or, less accurately, "the Pampa." Sixty years ago the area was indeed grassy pampa, free Indian hunting ground; simplicity marked the use of the land then and later as open cattle range. Today this land is no longer pampa in the true sense of an unwooded, unfenced, untilled plain; complexity has succeeded simplicity in the pattern of terrene occupancy. The open pampa has given way to enclosed fields occupied by various crops grouped in farm units of contrasted types.

The form and orientation of land holdings, fields, and roads reflects still the simple uniformity of the natural background. But the uses of the land include cattle farms, grain farms, and hog farms, with alfalfa pastures, and fields of wheat, oats, and corn; thousand-acre fields and luxurious mansions in great *estancias,* ten-acre fields and mud huts in tenant *chacras.*

Thus complexity appears even in the rural pattern of a small district, apart from urban complications and apart from recognized regional differences from place to place. This complexity of development reflects, not complexity of natural environment, but fecundity allowing success in many ways.

The pattern is unstable. Perhaps one sort of land use may supersede the present competitors for the land, and uniformity may be established over a considerable area. Yet this will not be the old simplicity of the pampa, but a complex uniformity rooted in present intricacies of the pattern of occupancy.

RICHARD JOEL RUSSELL.

Dry Climate Boundaries in the United States.

The Desert and Steppe climates of the United States are defined in terms based upon the Köppen classification. A system of interpolation is introduced in order better to adjust formulae to gradual transitions between winter, evenly distributed, and summer precipitation regimes. Distributional areas are mapped upon the basis of records from over a thousand stations. The twenty years, 1901-1920, are selected for a special study of "Desert Years" and "Humid Years" for about seven hundred stations. Distributional areas are mapped in accordance with persistence of desert and of humid conditions upon the basis of nearly fourteen thousand records of individual years.

ELLEN C. SEMPLE.

Domestic and Municipal Waterworks in Ancient Mediterranean Lands: An adjustment to Geographic Conditions.

All ancient literatures reflect the concern of the Mediterranean peoples to secure a pure water supply ample enough to carry them through the summer drought. They were haunted by the fear that their water might fail in an excessively dry year, or be cut off by an enemy or become polluted. Consequently they took every precaution against these possible evils by the gradual development of elaborate waterworks which were consigned to the care of their

ablest citizens,—men like Themistocles, Cato the Censor and Frontinus.

The location of a farm, village or city was determined in large part by its command of an ample water supply susceptible of increasing exploitation with growth of population. Springs or fountains, abounding in the extensive limestone regions of the Mediterranean lands, had the outstanding advantage of hidden or protected sources which could not be easily contaminated. Hence the town or village spring was the early center of ancient community life. When its waters were collected in a tank or pool, this in turn became the larger nucleus, the gathering place for the men in the early part of the day, and of the women in the late afternoon, when they assembled, water jar on shoulder, to bring home the household supply.

If the water supply was not all equally good, drinking water was separated from that used for other purposes. The connection between severe droughts and epidemics early made itself apparent. Hence the boiling of drinking water as a simple form of prophylactics was devised at an early date, in Persia by 550 B.C. Aerated water of torrential mountain streams was preferred to stagnant cistern water, which, though distilled by the sun, soon became foul.

Heavy fines were imposed for the pollution of water supplies, and also for their theft, because the summer drought made water a marketable commodity. Beautiful architectural works were raised over the sources of springs, to add to their dignity, and often temples were built to lend them peculiar sanctity, so that contamination of a spring became an offense against a deity as well as a crime against the community. On the other hand, the citizen who beautified or improved or enlarged the municipal waterworks was regarded as a public benefactor. Hence the ambitious man often selected these means of furthering his candidacy for public office.

The great aqueducts constructed in all parts of the Roman Empire were successors to yet earlier rock tunnel tubes and earthenware pipes used to conduct water from the distant mountain sources to fountains or reservoirs in the ancient Mediterranean cities. The large concentration of population in Rome early contaminated the wells in the valleys between the seven hills, and forced the construction of the nine aqueducts to convey water from the mountains to the Imperial City.

FRANCIS P. SHEPARD (Introduced by W. W. Atwood).

Continental Shelf Glacial Troughs.

Study of the submarine valleys of the continental shelves has shown that they are almost as variable in character as the valleys of the lands. In many cases these underwater depressions resemble youthful river valleys. Others suggest fault valleys. A third group resembles certain broad glacial troughs of the lands. There are many reasons to believe that this last group has been cut by glaciers. This type is confined to the continental shelves bordering glaciated coasts. In many cases these troughs represent marine continuations of typical glacial fiords. In other cases they occur off deep estuaries which were the seat of ice tongues during the Pleistocene. These estuaries have submerged hanging valleys on the sides, deep basin depressions with shallower sills, and trough shapes like fiords, but differ from fiords in the lack of high precipitous walls. These seaward extensions of fiords and estuaries have the comparatively straight walls, broad bases, and undulating longitudinal profiles of glaciated valleys. In some places, the soundings and bottom samples suggest morainic accumulations within these marine troughs.

The comparatively straight and steep sides of certain of these features have been interpreted by several geologists either as fault scarps or fault line scarps. Even very ancient fault zones are somewhat subject to earthquakes. Since many cables cross these troughs it is important to know whether or not they are bounded by faults. If the evidence that they are of glacial origin is correct, they need not necessarily be considered as dangerous places for cable crossings.

JULIA M. SHIPMAN (Introduced by Ellen C. Semple).

Physical Factors Affecting the Distribution of Water Through an Urban Area, as Illustrated in Worcester, Massachusetts.

The water supply of a city is one of the most vital factors in its development, throughout its history. It may determine the original site; promote its growth; and limit its size and character. Worcester illustrates all these facts. The initial settlement was made with respect to a spring of potable water. Gradually the settlement outgrew individual supplies and demanded community supply and distribution. The amount of water available, the site for storage, and the method of distribution has been a direct response to the terrain. Climatic conditions, and the irregular

growth of the city, due to physical factors, have increased the cost and required many adjustments in the distribution system.

HELEN M. STRONG.

How Business Is Using and Might Use the Science of Geography.

This paper discusses the results of a questionnaire sent out by the Geographic Section of the Bureau of Foreign and Domestic Commerce to members of the Association of American Geographers and a few other geographers, asking what practical services they had been asked to render in the field of applied geography, and what business activities might advantageously utilize the services of geographers. The replies revealed three facts of major importance to geographers.

I. Business interests are calling upon geographers who are responding with technical geographic services. Of the geographers replying to the questionnaire, 42 have rendered important services, and 27 have answered rather casual inquiries. The other 23 were engaged exclusively in teaching and research.

Reconnaissance studies have been made of cities and regions. Requests have come from travellers wishing to know something about an area they intend to visit, but not on the main-travelled routes. Investment companies have asked for a detailed description of land. Newspapers have obtained articles about regions of current interest to readers. To brokers has been supplied information regarding possible or probable fluctuations in supplies of commodities resulting from geographic conditions. Engineers constructing reservoirs, city planning commissions, chemical companies, investment houses, and others have asked for and received help from geographers. In addition to these services outside the Government, the Geographer of the Bureau of Foreign and Domestic Commerce has been called upon through the Geographic Section, of which she is chief, to render nearly 400 services during the past year to exporters. One investment house has employed a professionally trained geographer.

II. Business interests might use geographic science in many ways to advantage. The science of modern geography is comparatively new, and business interests do not realize the significance to them of the services of a modern professional geog-

rapher. Researches in this field will later function as applied science with the growing complexity of economic life, as have geology and some other sciences.

It would be difficult to find a manufacturer, exporter, investment house, transportation group, or producer of raw materials, who could not use to advantage geographic technique. The physical setting of every project is the fundamental conditioning factor in its success or failure, and the background into which it is rooted. Discussion of business trends and of possible development do not take these facts into consideration. The basically significant interrelationship of geographic elements is being entirely overlooked, and only a trained geographer can assemble and correlate these data.

III. Geographers are thinking together about the fundamental principles of geographic science and their application to modern life. Geography is clearly defined and its field of research offers much of value to the business enterprises of today.

LEWIS F. THOMAS.

The Sequence of Areal Occupance in a Section of St. Louis, Missouri. (Published in full in this issue).

EUGENE VAN CLEEF.

The Finns of Ohio.

The Finns in Ohio are concentrated in the northeastern section of the state. Many have come to these parts (1) from Finland direct, (2) some from other sections of the United States, more especially Pennsylvania, and (3) considerable numbers are native to the respective localities.

Studies of Finnish settlements in the Lake Superior District and in New England reveal conspicuous numbers of Finns either permanently located upon farms or in the process of acquiring land. A few others in urban centers are associated with agricultural industries, particularly dairying and in miscellaneous occupations. Those who spend part time upon the land may be employed in factories or mines or saw mills during the summer season or in the cutting of timber during the winter. In northeastern Ohio the last mentioned activities marked Finnish life some forty to fifty years ago. Today the Finns in this region are almost exclusively urban. Only a scattered few occupy farms. An occasional Finn in the city cherishes the hope eventually to live on a farm.

If the life of the Ohio Finns represents a permanent tendency in the evolution of Finnish settlements in the United States, then we may have here the basis for a forecast of the ultimate status of Finnish settlements in the Lake Superior District, New England, and other similar districts where the Finns are in about the same stage of activity as were the Ohio Finns fifty years ago. The landscape of the Ohio area lacks the boulder cover and lake frequency of other regions cited. Can it be possible that the absence of these features has caused the Finns to lose interest in farm lands? Again, where the Finns have settled in lake cities such as Painesville, Fairport, Ashtabula, Conneaut, and in Erie, Pennsylvania, they have located close to the shore of the lake. Has Lake Erie held a greater attraction for them than the hinterland which is devoid of water surfaces of consequence?

These are but a few of the problems still to be worked out whose solution may contribute much toward a possible scientific adjustment of migrating peoples to specific environments.

EUGENE VAN CLEEF.

A Report on a Canal Connecting Lake Erie with the Ohio River.

Since 1919 there has been under consideration a proposed waterway to connect Lake Erie and the Ohio River. The route in general follows the courses of the Sandusky and Scioto Rivers connecting Sandusky with Portsmouth. The project will be presented in January, 1931, before the United States Board of Army Engineers for its final recommendation.

Numerous arguments have been offered pro and con in the deliberations over this waterway. The proponents claim for it not only an economical route for the shipment of coal to Lake Erie and iron ore from the Lake, but in addition an effective medium for flood control, water supply for cities and industries, and a stimulus to wild life conservation. Then too, public recreational facilities are presumed to arise out of the reservoirs, forest preserves and other phases of the project. It is also cited as an adjunct to the equipment for national defense. Those opposed endeavor to show the cost of the investment would be so great, about $132,000,000, that it could not pay for itself; the waterway is less flexible than the railway, particularly with respect to adjustment of its capacity to handle increased traffic over a period of years; that all the claims made for it could be satisfied more eco-

nomically through the construction of rail and auto highways and specific building of flood control devices.

Apparently, our experience in matters of this kind is too limited to enable us to know definitely in advance whether of not the waterway would be worthwhile viewed as a transportation route. Some persons are suggesting that there is justification in constructing the waterway if only as an experiment; that such an experience warrants the expenditure of the estimated cost.

ROBERT DEC. WARD.

The Literature of Climatology. (Published in full in the March, 1931, issue.)

LANGDON WHITE (Introduced by W. W. Atwood).

The Iron and Steel Industry of Wheeling, West Virginia.

Wheeling is universally considered a "steel city." It is a part of the *Middle District,* which has nearly 50% of the country's steel ingot capacity and consumes about 46% of its finished rolled steel. It lies at no great distance from coking coal, is actually on good gas and steam coal, commands several easy routes to Lake Erie ore ports, lies on the Ohio River which supplies industrial water and which facilitates the assembly of some of the raw materials for iron-making as well as the marketing of finished products, and has splendid skilled labor of the second and third generation.

The city began as a frontier settlement in 1769; it built its first iron mill in 1832. The two industrial stimuli were the presence of coal and the location at a cross-roads: the National Road crossed the Ohio River here. Cities invariably spring up where trade routes cross.

Wheeling always has specialized on finished and semi-finished steel products; its distance from the trinity of raw materials has not been conducive to the manufacture of heavy products; rails, for instance, never have been an important item despite several attempts. In short, Wheeling has succeeded "only with products requiring skilled labor, where the cost of raw material is a relatively small proportion of the total cost." When the prairies of the West were being settled and homes were springing up by the hundreds of thousands, Wheeling became the nail capital of the country. As long as the cut nail reigned, Wheeling retained its eminent place, but lost it with the appearance of the wire nail.

One serious disadvantage of this city for the successful production of iron and steel has been its dearth of level land for the

growth of established plants and for the erection of new ones. The hills that border the narrow ribbon of flood plain restrict the space available. Moreover, the railroads hug the bank of the river to the exclusion of industry over a large section of the frontage.

Looking at all the major location factors that enter into the iron and steel industry of the present, it appears that the disadvantages of Wheeling outweigh the advantages. This would appear to be indicated by the desertion of Wheeling by the United States Steel Corporation and by the disappearance of several of the small concerns. The story of steel in Wheeling today is the story of the Wheeling Steel Corporation—a strong, local independent. It seems to the writer, however, that Wheeling will retain its place on the iron and steel map of the United States, because the metallurgical industry has become decentralized, buyers of steel are everywhere, the local market is important, the Wheeling Steel Corporation is keeping its plants up to date, and the Ohio River makes possible the shipment of products to markets from which Wheeling would be barred if solely dependent upon rail deliveries.

DERWENT WHITTLESEY.

The Urbanization of a Farm Village.

At Ellsworth, Maine, the original white settlers, arriving by sea, took up subsistence farms along the upper end of a long, narrow estuary and the lower reaches of the tributary river, on rough lands overlaid by podsol soils evolved chiefly from marine clay, but in places from sandy-gravelly glacial outwash. Seafood supplanted the meager crops of a modified continental climate.

Before subsistence farming had time to find adjusted expression in the cultural landscape, a growing market for timber products diverted local energy. Winters came to be devoted to logging in the coniferous forest of the hinterland; Springs to driving logs down the freshets to the vicinity of Ellsworth village; Summers and Autumns to sawing these logs into long lumber, staves, or shingles with the abundant waterpower of the river, which falls 87 feet within two miles of its mouth, and to hauling and stowing aboard schooner the products of the sawmills. Farm clearings were allowed to revert to forest, the houses being occupied by lumber workers unable to obtain quarters in a boom town. Shoe and knitting factories employed womenfolk of men at work in wood.

The heyday of lumbering was succeeded by desuetude, as virgin conifers disappeared before the ax. Reconquest of the land for subsistence farming was out of the question, because podsol soils on rough terrain have not repaid the labor cost of clearing since railroads opened up the fertile Middle West. Most of the power formerly used for sawing became converted into electricity for shipment out of the locality. Factories closed as population declined.

Chorologic rejuvenation has come through tourism. Ellsworth lies on a route-focus less than 200 miles from a favorite tourist goal of New England—Mt. Desert Island. As market-town for both Island and scenic mainland, and as distribution point for summer visitors arriving by rail or by automobile, it bustles with activity in summer and hibernates from October to June.

In the chorologic landscape can be read the sequence and the character of terrene occupance. Main Street is the lower portion of the steep, coastal road which rises from the estuary head (foot of falls) to join the second main highway of the region and to tap the railroad. A dilapidated business street fronts the decayed wharves. Its crossing of Main Street established the business center. Astride its prolongation toward the falls stands the civic center on high ground. The residential sections, chiefly of frame, story-and-a-half cottages and simple two-story houses, cling to the slopes bordering the estuary and parallel the river to the uppermost fall. On every country road beyond the uninterruptedly built-up area are shacks of the poorest villagers.

FRANK E. WILLIAMS.

Hydro-Electric Development in Pennsylvania.

The colonials of Pennsylvania were among the first to use direct water power in their development of early industries. The growing size of manufacturing plants, the use of steam, the presence of coal and many minor factors led the industrialists of this and other sections to change over largely to use of steam power.

Later, with the introduction of electric power and the ability to transport it reasonable distances without appreciable loss, water as a source of energy again came into its own. Pennsylvania, however, despite its rugged topography and fairly abundant and evenly distributed rainfall has not developed its hydro-electric power to such a high degree as some other industrial sections. Owing to the large population of the state and the high degree of

industrial development this commonwealth is one of the greatest markets for electric power in the country. A very large portion of this, however, is steam-electric power rather than that generated by water.

There are many minor reasons for this lesser use of water for electric power, but the all-important factor is the presence of abundant good coal within, and at no great distance from any part of, the state.

Exhibit at the Worcester Meeting

MAPS OF KENTUCKY, BY JOHN FILSON.

In compliment to Professor Ellen Churchill Semple, LL.D., native of Louisville, Kentucky, and resident of Worcester, Massachusetts, there was exhibited throughout the period of the Worcester meeting, photostat copies of eleven different versions of John Filson's *Map of Kentucke,* together with a portrait of John Filson. The maps displayed were printed in the United States, in England, and in France, between 1784 and 1794. The exhibit and the following brief account of the maps shown, are the work of Colonel Lawrence Martin, Chief, Division of Maps, Library of Congress.

Filson's *Map of Kentucke* was first printed at Philadelphia in 1784 to accompany his book entitled *The Discovery, Settlement And present State of Kentucke,* which was published at Wilmington, Delaware, in the same year. Only a dozen of the original issues of the map are known to have survived. These are in the library of a well-known New England collector, in the Library of Congress, in the British Museum, in the private library of Dr. A. S. W. Rosenbach of Philadelphia, in the Huntington Library at San Marino, Cal., in the Historical Society of Pennsylvania, in the Archivo Historico Nacional at Madrid, in the British Colonial Office at London, in the private collection of Mr. C. W. Jones of Minneapolis, in the John Carter Brown Library at Providence, Rhode Island, in the Harvard College Library, and in the library of the New York Historical Society, respectively. There are about eight American editions or impressions, to say nothing of a French edition, two impressions of an English edition, a dozen full-scale facsimiles of one or another of the American editions, six ancient hand-made copies, and various small reproductions and Filsonesque maps, so that we now know of 50 versions of Filson's map from 1784 to 1930. The first edition of Filson's book with the map, sold in 1785 for seven shillings and sixpence, Pennsylvania currency, or about one dollar. The price has risen to $4200 in 1930.